





CIVIL AND SOILS ENGINEERING LAND SURVEYS AND DEVELOPMENTS

# CONSTRUCTION FOUNDATION REPORT FOR SEEPAGE CONTROL ADITS ABIQUIU DAM AND RESERVOIR, NEW MEXICO FEBRUARY 2, 1990

#### PREPARED FOR:

U.S. Army Corps of Engineers
Albuquerque District
P.O. Box 1580
Athoquerque, New Mexico 87103



#### PREPARED BY:

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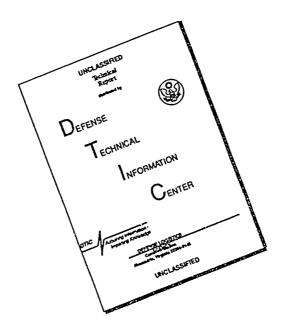
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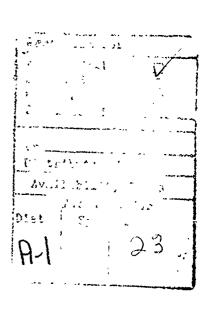
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#### I. INTRODUCTION

I-01. Location and Project Description - Presented herein is the Foundation Report for the Construction of Seepage Control Adits for Abiquiu Dam and Reservoir. The adits were constructed to capture and provide controlled drainage of reservoir seepage which had been emerging on the downstream abutments.

The site of the Abiquiu Dam and Reservoir project is about 35 miles northwest of Espanola, New Mexico, on the Chama River at river mile 33. The project consists of one seepage control adit and a secondary drift in each abutment of the dam. Adit and drift number one (1), on the left (north) abutment total approximately 1,250 feet in length. Adit and drift number two (2), on the right (south) abutment total approximately 1,000 feet in length. Radial lines of drill holes ranging in depth between 20 feet and 214 feet were drilled from the adits on approximately 20-foot centers in both adits to provide additional drainage.

- I-02. Construction Authority Corps of Engineers, Albuquerque District
- I-03. Report Purpose The purpose of this report is to present a detailed geological investigation of the foundation and overburden materials and conditions encountered during construction of the adits.
- I-04. Project History - Abiquiu Dam and Reservoir Project was authorized by the 1948 and 1950 Flood Control Act for the purpose of flood control and sediment detention. Construction of the embankment and spillway began in March 1959 and was completed in February 1963. The project consists of the following principal features: a rolled earth fill dam, controlled outlet works, an uncontrolled spillway located 4000 feet north of the left abutment, a maintenance building, service roads, an operations building and public use facilities. The project was modified to comply with the requirements of the Dam Safety Assurance Program. An embankment raise and spillway modification were required to provide adequate freeboard and to safely pass the revised probable maximum flood. Additional downstream toe protection on the dam was provided due to the increased discharge and higher tailwater elevations. As the result of the embankment raise and spillway modification, the dam crest length was increased from 1,540 feet to 1,800 feet, the maximum height above the stream bed changed from approximately 325 feet to 340 feet, and the spillway was widened by 28 feet to a total width of 68 feet. Due to the required embankment raise, the dam crest road was removed and then replaced upon completion of the embankment raise. Construction of the road was completed on August 30, 1986. [1]

Supplemental drilling and grouting programs were conducted during 1966 in an attempt to reduce seepage around the control shaft and through the left abutment. Sixteen (16) holes were drilled around the control shaft to an elevation of 6,115. A total of 4,480 linear feet of holes were drilled and grouted, and 2,317 cubic feet of cement was placed. Seepage into the control shaft was almost eliminated by the program. A 560 foot section of foundation was regrouted from station 3+90A to 9+50A and a 500 foot section of grout curtain was added on the left abutment. [1]

[ ] Refers to Appendix 1, List of References

- I-04.1 Grouting From late 1978 until late 1980, 2 additional grouting programs were completed. Under the first contract, 510 feet of foundation grout curtain was regrouted from station 14+70A to 19+80A. The curtain was then continued up the right abutment 500 feet. Under the second contract, the 1966 increment was extended 500 feet on the left abutment, and 500 feet of the curtain was extended on the right abutment. [1]
- Piezometers Fourteen (14) piezometers were drilled as a modification to the grouting contract of 1966. In 1977, twenty-two (22) additional piezometers were drilled on the right and left abutments and the downstream side of the dam. In 1986, five (5) piezometers were drilled on the right abutment, one (1) in the embankment and four (4) on the left abutment. Fifteen (15) embankment piezometers were also drilled in the downstream horizontal drainage blanket and stream alluvium and four (4) in the downstream random fill zone of the embankment. (See Plate 2, Appendix 10 for piezometer locations.) [3]
- I-04.3 <u>Drainholes</u> In 1966, the first series of drainholes were drilled in the left abutment which consisted of twelve (12) holes. Twelve (12) additional holes were drilled in the right abutment in 1977. During 1979, four (4) holes were added to the left abutment and five (5) on the right abutment. In 1980, three (3) holes were added on the left abutment and four (4) holes to the right abutment. (See Plate 2. Appendix 10 for locations.) [3]
- I-05. <u>Location of Structures</u> Structures discussed in this report are Portals, Adits and Drifts. Locations are shown on Plate 2, Appendix 10. [3]
- I-06. Contractors Excavation of portals, adits and drifts along with portal construction was completed by Elmore Pipe Jacking. Drainhole drilling and drainpipe installation was completed by Continental Drilling. Both companies are based in California. Electrical and surveying services were contracted through local businesses. Surveying services were provided by Ray Ortiz Surveying from Santa Fe and electrical services by Zia Electric from Abiquiu.
- I-07. Supervision Supervision of all activities including excavation of portals, adits and drifts along with installation of portal structures, shotcreting, rockbolting and all drilling activities was carried out within each contracting company. Corps of Engineers provided overall inspection.
- I-08. Quality Control Organization Contractors established and maintained quality control throughout the project with the use of the following tools or tests:
  - Use of a laser to give correct lines of excavation and grade for adits and drifts.
  - Cores of tunnel walls taken to obtain shotcrete thickness and strength.
  - Pull tests performed to obtain rockbolt strengths.
  - Drilled pilot holes after shotcrete installation to check thickness.
  - Directional surveys taken of all inclined drainholes and 10% of all vertical drainholes to check if target area was hit.

Corps of Engineers inspected and maintained the Contractor's quality control programs by sampling and testing to confirm results. Data was not provided for this report.

I-09. Design Staff - Design for the seepage control adits at Abiquiu Dam was done by Tierra Engineering Consultants. Design staff includes the following:

Richard B. Catanach Alan J. O'Neill Dr. Greg Korbin Project Engineer Consultant - Geology and Tunneling Consultant - Rock Support Systems

#### II. FIELD INVESTIGATION

II-01. Summary and Description - Geologic field mapping of the portals, adits and drifts was carried out using peripheral geologic mapping techniques in order to log all geologic features present regardless of their positions on the tunnel walls. All materials encountered along with overburden materials were classified and described in accordance with Table B-2 of Corps of Engineers Manual EM1110-1-1804, "Geotechnical Investigations", dated 29 February 1984. Geologic maps were also prepared for the north and south portal faces. All pertinent features such as fractures, joints, bedding planes, seeps and faults were included in the maps. Mapping is presented as Appendix 7.

A detailed log was kept for each drain hole drilled. Samples were taken and analyzed to provide a detailed description of the lithology and to assist with the proper positioning of perforated PVC drainpipe. Logs are presented as Appendix 11.

#### III. PREVIOUS EXPLORATIONS

- III-01. Explorations and Results Previous explorations at Abiquiu Dam include borehole drilling and a seismicity study of the area. Both programs provided data to determine rock properties for tunneling methods, rock support and stability of the adit project.
- III-01.1 Subsurface Exploration Subsurface exploration along the proposed alignment of the adits was completed on October 10, 1987. This program consisted of nine (9) vertical and two (2) angle borings along with additional testing to determine rock properties including compressive strength, density, and swell pressure. Refer to Appendix No. 2 for test results.
- III-01.2 Seismicity Study A detailed seismological study was completed for Abiquiu Dam and Reservoir on June 6, 1986. The study concluded that the most severe earthquake at the site would be a magnitude 7 event. It was concluded that if such an event were to take place at Abiquiu Dam, the adits and drifts would not be prone to earthquake damage due to their location away from direct contact with major faults. [2]

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#### IV. GEOLOGY

IV-01. Regional Geology - The canyon containing Abiquiu Dam was cut by the Rio Chama into the shales and sandstones of the Permian Abo formation and the lower sandstone of the Triassic Chinle formation. Both of these rock units are relatively flat lying and highly fractured. They extend throughout the southeastern Chama Basin. The Chama basin is an elongated, north plunging depression bounded on the west by the Gallina - Archuleta arch (San Pedro Mountains), on the northeast by the Brazos uplift and on the north and south by the San Juan and Jemez volcanics respectively. The Chama syncline is also present and here trends approximately north-south and is located in the center of the basin.

On the east, within 1.5 miles of the dam, the Chama basin is bounded by the Espanola Basin which is one of the major basins of the Rio Grande Rift; a structural feature that extends the length of New Mexico. This boundary is marked by northeast trending, high angle normal faulting. The sedimentary rocks present within the basin range in age from Pennsylvanian to Pliocene. Igneous rocks of the basin are divided into the Pre-Cambrian intrusives of the San Pedro Mountains in the west and the Pliocene and Pleistocene extrusives of the Jemez Mountains in the south. The southeastern part of the basin is characterized by broad folds and gentle regional dips to the north and west. Steeply dipping normal faults with a general north to northeast trend are common and often exhibit throws in excess of 200 feet. Jointing is generally north-west to north-east and are nearly vertical to vertical. [1]

The close of the Cretaceous Period culminated in wide spread crustal movements that have caused a mosaic of fault blocks, erosion and peneplanation, and deposition of approximately 2,000 feet of sediment. Additional deformational crustal adjustments near the close of the Tertiary Period uplifted and faulted the region, outlining the broader features of the present day topography. Quaternary time brought long periods of erosion interrupted by volcarism. Successive piedmonts and broad valleys were incised, and dissected, leading finally to the modern floodplains, especially in the reservoir area. [1]

IV-02. Site Geology - Overall site geology was presented in Design Memorandum No. 4, "Geology, Soils and Construction Material", dated October 1955. Results were supplemented by additional core holes along or near tunnel adits and additional testing to determine rock properties for tunneling methods and rock supports.

A review of the abutment rocks and leakage conditions indicates that the more indurated, more competent stratum within a formation shows mon intense deformation joints, while the more plastic, more yielding portions show poorly developed, or no jointing. Numerous vertical or high inclined joint planes are usually confined to individual stratum and stop at bedding planes or are there offset and continue downward to one side or another. [1]

Before this project was undertaken an increasing number of rock slides and bank failures both in the reservoir area and downstream of dam had occurred. The abutments of the dam and the canyon walls downstream of the dam experienced wide spread wetting from abutment seepage. Several problems occurred as a result of this. [1]

- Controlling, routing and measuring the seepage was an increasing problem.
- The wide spread wetting of the mudstone layers along the abutments and downstream of the dam caused stability problems resulting in numerous rock slides.

IV-03. Lithology - Permian and Triassic age rocks are exposed at the dam site. Permian age rocks belong to the Abo formation which is up to 1,500 feet thick and varies in composition with depth. The upper section is a massive, red to dark brown mudstone with irregular lenses and masses of green sandy mudstone and clay. The lower section of the formation is a series of interfingering lenses of silty mudstone and silty sandstone. The dominant color is red to brown, but some units are purple to green. Individual beds vary horizontally in both thickness and composition. The sandstones are extensively jointed and the mudstones display numerous minor joints. Joints faces in the mudstone are commonly striated and slickensided in random orientations. [1]

The Agua Zarca Sandstone member of the Triassic Chinle Formation overlies the Abo formation. Above the Agua Zarca Sandstone are the Salitral Shale Tongue and Poleo Sandstone members of the Chinle Formation, which extends up to the rim of the canyon. The Agua Zarca Sandstone is dominantly white to buff colored, medium to coarse grained, quartzitic, well cemented and highly jointed. Locally there are thin seams and zones of conglomerate with cobbles up to 4 inches in diameter. All sand and gravel size material is well rounded. Reddishbrown mudstone occurs as irregular lenses and seams. [1]

- IV-04. Ground Water Recent analysis of the regional groundwater indicates that prior to construction of the reservoir, the Rio Chama was an influent stream. Now that the reservoir is in place it serves as a source of water for flows downstream of the dam which are combined with groundwater flows in the downstream area. For most of the reservoir, the higher base level would result in a relatively slight lowering of gradient from the recharge zones to the valley; and a slight increase of the down-valley gradient. These changes would result in minimal change to the regional flow net; the direction of groundwater flow would remain nearly perpendicular to the valley. In this condition the reservoir would be a zone of groundwater discharge, as was the river before it, not a source of seepage. The exception to this outcome would occur near the dam site itself, where the down-valley flow does not encourage seepage to occur from the reservoir. It would be expected that this water would be discharged to the alluvium below the dam, within to 1 to 1.5 miles with the major portion occurring near the dam site. [1]
- IV-05. Rock Engineering Characteristics Overburden and subsurface rock characteristics were obtained from the drilling project of 1987. Cores were taken and tested for rock strength, density, and swell pressure. The test results are presented in Appendix 2.
- IV-06. Construction Conditions Rock conditions overall were very favorable. The sandstone which the adits were driven into was moderately hard to hard and moderately to highly fractured. Although the sandstone was highly fractured in areas, steel sets were not necessary for wall support due to the strength of the sandstone and the orientation of the joints. Rockbolts and shotcrete were all that was necessary to support the tunnel walls. Loose rock was found in several areas where joints did intersect. All such loose material was anchored with rockbolts or knocked out entirely. See photographs, Appendix 9.

A 2 foot thick section of a well cemented sandstone was encountered in the South Drift between stations 0+62 and 1+25. This area was extremely hard and required several changes of teeth on the roadheader to enable excavation to be completed. Samples were taken and tested by the Corps of Engineers. Test results indicated compressive strengths between 25,000 - 30,000 psi.

Faulting was very moderate. Very few areas showed any sign of faulting. Where faulting was present, displacement ranged from 1 inch up to a maximum of 6 inches. Water seepage was not always present within these faults but when it was, amounts were relatively high. Seepage flows versus lake levels are presented in Appendix 3. Typical faulting is shown in photographs, Appendix 9, and mapping is presented as Appendix 7.

Both adits were started with their inverts in mudstone. The mudstone was stable with only minor sluffing and caused no difficulties in adit construction.

The majority of water intercepted by the adits flowed down the joints and out either at the sandstone/mudstone contact or at or near the contact between the tunnel wall and the invert. Very little water seepage was encountered along the crown or tunnel ceiling. As the tunnels were advanced seepage also advanced leaving previously wet areas dry. Seepage waters were minor and caused no difficulties in adit construction. Some of the seepage waters were collected and used in the excavation and drilling operations.

#### V. SPECIAL DESIGN CONSIDERATIONS

V-01. Portal structures were extended 14 feet out from the portal faces at each of the two adit entrances. The structures were constructed using steel rigid frames enveloped in concrete and blanketed with rock fill to protect the portals against damage from falling rock. A phasing schedule with specified portal configurations was prepared and included in the contract documents. The portal specified for adit construction was not built until adit excavation was complete. During adit excavation a steel framed structure with wood planking was used for portal protection. See photograph Appendix 9. The structure was approved by Corps personnel to avoid losing excavation time building the permanent structure and to also avoid possible damage to the permanent structure during excavation. Refer to Plans and Specifications [3] and plate 14, Appendix 10, for dimensions and configurations and refer to photos, Appendix 9 for as-built photographs.

#### VI. ADIT CONSTRUCTION

- VI-01. Overburden Excavation Benches above each portal face were excavated to initiate construction. The bench on the North Portal was specified to limit the depth of exposed rock face had line drilling been used. The bench at the South Portal was excavated by the Contractor for his convenience. After excavation of the adit portals to invert elevation, chain link fabric along with shotcrete were applied to each portal face to protect and preserve the rock. No other overburden excavation was required. Refer to Appendix 9 for photographs.
- VI-02. Excavation Procedures and Equipment The north and south portal faces and benches were excavated using a backhoe mounted rock hammer. The plane of excavation for both portal faces was approximately 2 vertical: 1 horizontal (60° from horizontal). Once the excavation was completed, chain link fabric held with 6 foot rockbolts was installed on the portal faces followed by a 2 inch cover of shotcrete to insure portal face stability. Once the shotcrete had cured, tunnel excavation proceeded. [3]

Adit Excevation - Excavation of the adits, drifts and portals was accomplished using a fully articulated boom excavating machine, commonly known as a "roadheader". Two such machines were used throughout the length of the excavation work. The first roadheader put into operation was an Alpine Miner, Model AEC-250, H Series. It was used exclusively from June 1, 1989 to July 25, 1989. On July 25, 1989, a larger roadheader arrived on site and was put into operation on July 27, 1989. The new roadheader was a Dosco, Model SL 120. It replaced the Alpine Miner while it was down for repairs. On August 12, 1989, the Alpine Miner was repaired and put into operation along with the Dosco. Both roadheaders were used for the remainder of the excavation work. Other machinery used in the excavation of the portals, adits and drifts included two SF 342 Muckers, 1 John Deere 210 C Loader, 1 Caterpillar 950 E Loader, 1 Toyota Skip Loader, 1 Caterpillar 8356 Backhoe and 1 Semi-Truck. A batch plant was also used for preparing shotcrete as required by the plans. Refer to Appendix 9 for photographs.

VI-03.

Excavation began with the south portal on June 1, 1989 and ended in the North Adit on October 20, 1989. (Refer to maps for chronological record.) A total of 2,250 feet was excavated in 103 actual working days for an overall average of 22 feet per day.

Several days were lost completely or shortened due to mechanical breakdowns. A single ten-hour excavation shift followed by a ten-hour support shift was scheduled each day until August 17, 1989. At that time a double shift begin which consisted of two, ten-hour excavation shifts and two, ten-hour support shifts. Each shift excavated one tunnel while supporting another. A total of 130 excavation shifts were completed which averaged approximately 17 feet of advance per shift.

In order to excavate the tunnel to grade and within reference lines, a laser was set up at a known station and elevation. The laser, along with the use of a measuring rod, gave such direction. Although steel sets were on site, conditions did not warrant their use. Therefore, overexcavating for their installation was not necessary. Refer to Plans and Specifications, [3] and plate 11, Appendix 10 for typical adit sections.

Excavation of the north and south adits and drifts alternated depending on the working roadheader's availability and down time for settlement pond relining. The following dates are associated with the excavation of each tunnel:

June 25 - July 20

- August 23 September 13

  2) South Drift July 17 July 25
  August 22 September 6

  3) North Adit July 26 August 19
  September 9, September 18 October 2
- 4) North Drift August 3 August 19 September 11 - September 16

1)

South Adit

Procedures for excavation and support of each tunnel were as follows: As the roadheader excavated and advanced forward, all pulverized material was carried back into a mucker via a conveyor belt. It was then removed from the adit and taken to the waste area. Throughout each excavation shift, reference lines were checked using a measuring rod and the laser. At the end of each shift, prior to pulling the roadheader out, the reference lines and grade were again checked.

Any deviation from design plans was corrected at this time. A positive grade of 1%, as required for drainage, was excavated throughout both adits and drifts. Once the roadheader was pulled out of the newly excavated area, the area could then be supported. Support included installation of 6-foot rockbolts and a 2-inch application of shotcrete. Rockbolt holes were first drilled using hydraulic drills. Quick and slow set resins (3-6-inch tubes of each) were then installed in the hole followed by the rockbolt. A plate and nut were then installed on the end of the rockbolt and tightened with a pneumatic torque wrench. Rockbolts were installed in rows spaced 4 feet apart with alternating 6-and 5-bolt patterns. Weep holes were drilled to divert water away from the tunnel walls to provide a dry surface for the shotcrete bond. Shotcrete was applied from the crown down to the invert of the tunnel. Although gauging pins to insure shotcrete thickness were specified the contractor relied on past placement coring to test shotcrete thickness and use of rock bolts. A 2-inch thickness was specified. At the beginning of the project, shotcrete was also applied to the invert, a modification of the specified structural concrete mud sill. This practice was abandoned due to the weight of the machinery breaking up the invert and rendering it useless. After this practice was abandoned, gravel was used to protect any exposed mudstone in the invert and to assist in traction for the machinery. After each tunnel was completed, the gravel invert was removed to a depth deep enough to expose fresh rock. This process was completed in sections small enough to be covered with concrete within the maximum exposure time for the mudstone. To avoid water contact with the freshly exposed rock surface, dams and pumps were set up to divert water away from the exposed area. This step formed the sub-invert necessary for protection of the invert during the drilling program. Once the drilling was completed a finished invert with water channels was installed.

VI-04. Dewatering Provisions - Before adit excavation work could begin, the construction of settlement ponds had to be completed. Three ponds on each side of the canyon floor were excavated and lined. The ponds were designed to capture all water exiting the adits in order to settle out any particulates before discharging it into the river. The ponds were necessary to comply with State and Federal clean water regulations. On the south side, problems arose immediately after the ponds were filled. Water began to seep out of the ponds creating sluffing of bank material and the formation of settlement fissures on the road adjacent to the ponds. After much consideration, the ponds were pumped out, cleaned and relined. This, along with regular mucking out, provided an adequate volume for particulates to settle out and eliminated further problems. See photographs, Appendix 9 for pond locations.

Water discharge from the adits was as follows: On the north side discharge was 540 gallons/min. after the adit was completed and remained at 540 gallons/minute after the drainholes were installed. On the south side discharge was 300 gallons/min. after the adit construction and 310 gallons/min. after the drainholes were installed. Significant increases were not anticipated in either adit, as the reservoir is quite low. For further information on water discharge and pool elevation see Appendix 3.

VI-05. Problems Encountered - Very few problems were encountered during the excavation of the portals and adits. The contractor had difficulty maintaining shotcrete adherence especially on wet mudstone and other areas of wet rock. After the final floor was poured, all areas were re-shotcreted and the shotcrete held. The only other construction problem was a hard digging area, which was

referred to in paragraph IV-06. All other problems were mechanical in origin. The conveyor belt assembly along with the gear box on the roadheaders were a source of continual breakdowns and delays. The alpine conveyor system would often bind up and shear roller pins when it became buried in muck, especially where the invert was in mudstone.

VI-06. Drainhole Drilling - The drainhole drilling program began October 5, 1989 and ended January 19, 1990. Two hundred and ninety-seven (297) drainholes were drilled which included 111 vertical upholes, 111 vertical downholes and 75 inclined holes. Vertical upholes were installed 20 feet apart, slightly off center to leave room for ventilation lines. Vertical downholes were installed at 20 foot centers. Approximately 24,000 feet were drilled in 88 days for an average of 273 feet per day. Several days were completely lost or shortened due to mechanical breakdowns. Design drawings showing drainhole locations are presented in Appendix 10. One drain hole in the south adit at station 5+21 day lighted due to length of hole taken from adit wall instead of center of adit.

The work effort began with one drilling rig in the South Drift on October 5, 1989. It was used for about a week before the work effort was expanded to include four working rigs per shift and two shifts per day. The drilling rigs used were all air driven rotary drills. The following is a list of all rigs used in the drilling project: 2 Stanwicks, 1 Dodge, 1 CP65 and 2 Ingersol Rands. For a chronological record of the drilling program refer to Appendix 5.

No problems were encountered while drilling the drainholes in the South Adit and Drift. In the North Adit and Drift, a hard section of white, medium to coarse grained, well cemented sandstone was encountered. This section was approximately 12 feet thick and was located between elevations 6217 to 6229 feet. Drilling in this area was very slow, averaging 2.5 hours per 5 foot rod compared to 30 to 45 minutes per 5 foot rod in the slowest sections outside of this area. A core was taken by the drilling Contractor, however, test results were not made available. The only other source of problems in drilling the drainholes in the north and south areas were mechanical breakdowns. The drilling subcontractor had to return to the site after demobilizing the complete some holes in the north adit that were not drilled to depth specified.

Procedures for drainhole installation are as follows: Drainholes were drilled to required lengths using an NX size bit and water as the drilling fluid. Drainholes were surveyed using a directional surveying tool. All inclined holes were surveyed every 20 feet and 10% of vertical holes were surveyed at the start, halfway, and the end to check if the target area was hit. All holes surveyed achieved target. If water discharge was encountered, a flow test was run and results were recorded. Once the drainhole was completely drilled out PVC pipe was installed to drain off areas of seepage and potential areas of seepage (sandstone) and to block off mudstone areas. Perforated PVC pipe was installed where drainage was anticipated and solid PVC pipe with packers in the non-seepage areas. The exposed PVC pipe at the tunnel wall was then grouted in place. Refer to Appendix 9 for photos.

Overall observations of the drilling project are as follows:

- The lower sandstone formation, which each adit was driven into. drilled relatively fast.

- The mudstone formation separating the lower and upper sandstone along with the underlying mudstone formation drilled very slow. This was due mainly to the inability of the water to be directed to the tip of the cutting bit in order to clean out the hole as the bit was advanced. As the project progressed different bits were used which reduced this problem.
- The upper sandstone formation drilled moderately fast however it drilled slower than the lower sandstone due to the fine grain size and presence of mudstone.
- Most downholes (inclined and vertical) contained some amount of water discharge. It varied from 5 gallons/minute down to a trickle.
- On the south side the majority of upholes were dry. Where water did exist it varied from a few pints/minute down to a trickle. On the north side, the majority of upholes contained water varying from a couple of pints/minute down to a trickle.
- Some initial discharges were up to 10 gallons/minute before leveling off to a few pints/minute.

#### VII. MAPPING

VII-01. Portals - The peripheral geologic mapping method was used to map the adits, drifts and portals. The following areas with their associated structures were mapped.

The North Portal (No. 1) was excavated and constructed on a bench at elevation 6080. It lies within the contact between the Abo Mudstone below and the Agua Zarca Sandstone above at elevation 6084. A single one inch open vertical joint was present in the sandstone which ran along the center of the portal and had an attitude of N 85° E. The North Portal foundations were excavated and installed in the Abo Mudstone. The Abo Mudstone is dark red to brown in color with a one foot thick dark blue section above topped by a two to three inch green clay layer. It is soft to very soft and unfractured. The Agua Zarca Sandstone is white in color, moderately hard to hard, medium to coarse grained and conglomertic with depth.

The South Portal (No. 2) was excavated and constructed on a bench at elevation 6093. It was also located within the contact between the Agua Zarca Sandstone and the Abo Mudstone at elevation 6094. Two (2) 1 1/2 - 2-inch open joints were present in the sandstone. The South Portal foundations were excavated and installed in the Abo Mudstone. The composition of the sandstone and mudstone were the same in the South Portal area as in the North Portal area although beds of similar lithology varied somewhat in thickness between portals.

VII-02. Tunnels - Structures that were encountered and mapped during the construction of the adits and drifts were joints, bedding planes, seeps and faults. The following is a brief description of all such structures. For a more detailed examination refer to maps, Appendix 7.

VII-02.1 <u>Joint Separation and Spacing</u> - Joint separation and spacing varied throughout the north and south adits and drifts. Separation ranged between 0 (tight or closed joints) and 2 inches (open joints). Spacing varied from 4 to 100 feet for open joints and 2 to 20 feet for closed joints. Open and closed joints were restricted to the Agua Zarca Sandstone. At the contact between the Agua Zarca Sandstone and the Abo Mudstone the joints disappeared. There were however a few areas within the Mudstone (near the contact with the sandstone) where slickensides were present which may indicate that the joints continued through the mudstone. Refer to maps in Appendix 7 for orientation configuration of joints.

The North Adit was approximately 900 feet in length and started at Station 1+82. Open joint spacing on the first 300 feet (1+82 to 4+82) averaged 15 feet. The next 100 feet (4+83 to 5+84), spacing was much tighter ranging between 4 to 6 feet. The remaining length of the tunnel from Station 5+85 to 10+80, open joints were few in number and spaced anywhere from 5 to 100 feet apart. Closed joint spacing alternated from tight to wide throughout the length of the tunnel. Between station 1+82 to 4+98 and 6+98 to 8+28, spacing was 2 to 10 feet apart. Spacing widened to 10 to 15 feet between Station 4+98 to 6+98 and 8+28 to 10+80.

The North Drift was 360 feet in length and started in the center of the North Adit at Station 2+89. From Station 0+00 to 0+62, open joints were spaced 5 to 10 feet apart and intersected each other producing loose rock. From 0+62 to 3+60, open joint spacing ranged between 10 to 50 feet apart. Closed joints which were present between Station 0+85 to 1+90 were closely spaced, 2 to 10 feet apart. The South Adit was approximately 784 feet in length and started at Station 0+66. Open and closed joint spacing alternated from tight to wide throughout the length of the tunnel. Open joints between Station 0+76 to 4+36 were spaced from 5 to 20 feet apart. From Station 4+82 to 5+18 spacing tightened to 1 - 10 feet then widened from Station 5+18 to 8+50 to 25 - 140 feet. Closed joints between Station 0+66 to 5+06 and 6+46 to 7+66 ranged between 2 and 10 feet apart between the previous two areas (5+06 to 6+46) closed joints widened out to 25 to 40 feet apart.

The South Drift extended 200 feet and started in the center of the South Adit at Station 4+50. Few open or closed joints were present in the South Drift. Where they did exist open joint spacing was 10 to 40 feet apart and closed joint spacing was 5 to 10 feet apart. Refer to maps for further details, Appendix 7.

VII-02.2 <u>Joint Orientation</u> - The North Adit was excavated in a direction running S89°W. All closed joints and most open joints encountered were oriented near perpendicular with respect to the tunnel. The directions of the joints were NW - SE and NS  $\pm$  10° to 20° with a dip of 70° or greater. A few open joints ran near parallel with respect to the tunnel with a direction NE - SW dipping vertically.

The North Drift was excavated in  $\epsilon$  direction N 31°W. All open joints and most closed joints ran near perpendicular with respect to the tunnel. Their directions were NE - SW and EW  $\pm$  10° to 20° with a dip of 70° or greater. Closed joints that ran near parallel to the tunnel had a direction of NW - SE and dipped 60° or greater.

The South Adit was excavated in the direction S 14°W to S 44°W. Both open and closed joints ran near perpendicular with respect to the tunnel. The direction of the joints was NW - SE with a dip between 60° to 85°.

The South Drift was excavated in the direction S 46°E. Closed joints ran near perpendicular to the tunnel while open joints ran parallel with respect to the tunnel. Closed joints had a direction NE - SW and dipped between 70° to 85°. Open joints had a direction NW - SE and dipped between 70° to 90°. For furth details refer to maps and joint orientation diagrams in Appendix 4, 7 and 10.

- VII-02.3 Faulting Faulting in the adits and drifts was moderate. Faulting was more abundant in the south area than in the north area. In the North Drift, no faulting was present. In the North Adit some faulting was present between Station 5+52 to 6+46 with displacements ranging from 1 to 5 inches. Two areas in the South Drift displayed faulting. At Station 1+20 faulting was present with a maximum displacement of 6 inches. Between Stations 1+47 and 2+00, more faulting was present but with smaller displacements (3 inches). The majority of faulting was encountered in the South Adit. Between Station 4+90 and 8+40, faulting was most abundant. Although faulting was greatest here, displacement remained low 4 to 6 inches for each fault. Faulting was concentrated in small groups of closely spaced faults, 2 to 4 feet apart. Groups of faults were separated 20 to 80 feet apart. Refer to Appendix 7 for details and Appendix 9 for photographs.
- Materials Encountered All adits and drifts were constructed in the lower Agua VII-02.4 Zarca Sandstone. Both North and South Adits began at the contact between the Abo Mudstone below and the Agua Zarca Sandstone above. The South Adit remained within the contact for approximately 360 feet (Station 4+24) and the north for approximately 320 feet (Station 5+02). A 1 to 3 foot thick continuous conglomertic bed existed above the Abo Mudstone for 335 feet in the South Adit and 400 feet in the North Adit before it pinched out. All tunnels remained in the lower Agua Zarca Sandstone throughout their lengths. The Agua Zarca Sandstone consisted of moderately hard to hard white sandstone, softer, but still moderately hard blue and brown sandstone, thin non-continuous beds of conglomerate and irregular pockets of black mudstone and conglomerate. All sandstones were moderately to highly fractured. One area which differed from this was between 7+08 to 7+65 in the North Adit. It consisted of a dark blue to black, soft, unfractured horizontally bedded mudstone which was restricted to the crown of the tunnel. (Refer to maps, Appendix 7 for detail and Appendix 6 for geologic sections along adits and drifts.

#### VIII. INVERT CONSTRUCTION

Unfinished concrete was used to form the sub-invert mudsill, and finished concrete to complete the adit invert. Prior to installation of the sub-invert the invert was excavated down to fresh rock. Dams and pumps were set up to divert water away from the fresh surface and concrete was placed to form the mudsill. The installation of the sub-invert was performed in small sections so the work could be completed quickly to protect the freshly exposed mudstone. Once the drilling program was completed a finished concrete invert was installed with water channels running down each side of the invert.

#### IX. FUTURE PROBLEMS

A large section of rock above the North Portal area broke off of the canyon wall during the first week of June 1990. A large block landed on the portal bench, narrowly missing the portal structure. Another block is beginning to form in front of a new set of encchelon cracks above the portal. Although this does not pose a threat to the adit or drift, serious damage may occur to the portal structure and the power station if such an event should take place. This problem was not related to adit construction.

A potential problem may exist in the adits themselves. Sluffing off of shotcrete protecting and supporting the mudstone has already been observed. If this should continue the mudstone would be exposed to water and air which would cause slaking and deterioration. If this should occur the mudstone could be protected by shotcreting again. This is a maintenance possibility and would not affect adit operation or safety.

The contractor used rounded river rock fill to protect the portals against damage from falling rock instead of specified angular rock removed during excavation of the portals. A new contract will replace the rounded rock with angular rock.

#### X. INSTRUMENTATION

No foundation instrumentation was installed in the adits or drifts at Abiquiu Dam and Reservoir. A weir was constructed within each portal to measure the seepage flows. Individual measurements of pressure or seepage at each drainhole are possible if needed.

#### XI. CONCLUSION

The adits were completed very nearly as designed with no significant construction problems noted. Water seepage, mudstone deterioration, fractures nor faulting presented any problems. Rock quality was good throughout and the geology did not differ substantially from the exploration holes. Tunnel and support methods selected (roadheader, rockbolts and shotcrete) were very appropriate and produced a completed project with no significant deviations.

# APPENDIX 1 LIST OF REFERENCES

#### **REFERENCES**

- 1. "Feature Design Memorandum Number 20, Seepage Control Adits, Abiquiu Dam, New Mexico", by Tierra Engineering Consultants, Inc., dated 19 February 1988.
- 2. "Seismic and Seepage Report for Abiquiu Dam" Rio Grande Basin, Rio Chama, New Mexico", by Tierra Engineering Consultants, Inc., dated 9 December 1986.
- 3. "Plans and Specification for Seepage Control Adits, Abiquiu Dam, New Mexico", by Tierra Engineering Consultants, Inc. dated 18 November 1988.

### APPENDIX 2

TESTING: UNCONFINED COMPRESSIVE STRENGTH, DENSITY AND MODULES OF ELASTICITY

# ABIQUIU ADITS UNCONFINED COMPRESSIVE STRENGTHS DENSITY AND MODULUS OF ELASTICITY

CORE	DEPTH	ROCK TYPE	COMPRESS. STRENGTH (PSI)	DENSITY (PCF)	MODULUS OF ELAS.
AB-C-1	119.6-120.4	SANDSTONE	3,140	147	
AB-C-1	132.9-133.5	SANDSTONE	3,300	. 148	
AB-C-1	174.1-175.1	SANDSTONE	1,569	140	
AB-C-1	250.5-252.0	MUDSTONE	1,146	142	
AB-C-1	257.4-258.5	MUDSTONE	321	134	
AB-C-1	260.0-261.0	SANDSTONE	2,879	151	
AB-C-1 ·	269.4-270.2	SANDSTONE	6,332	. 152	
AB-C-1	273.0-274.0	SANDSTONE	3,357	142	
AB-C-1	277.4-278.1	SANDSTONE	793		1.46E+06
AB-C-1	279.4-280.2	SANDSTONE	2,733	138	
AB-C-2	128.6-129.9	MUDSTONE	958	144	
AB-C-2	135.7-136.8	SANDSTONE	5,356	<sub>.</sub> 151	* 447 000 000 000
AB-C-2	147.7-148.8	SANDSTONE	3,545	146	
ABC-2	205.4-205.9	SANDSTONE	10,678 、	162	
AB-C-2	241.5-242.0	SANDSTONE	251	153	and and the law
AB-C-2	244.1-245.2	SANDSTONE	1,303	* ****	1.27E+06
AB-C-2	253.0-254.2	SANDSTONE	1,083	142	
AB-C-2	263.5-264.5	MUDSTONE	907	145	gan are ma
AB-C-3	24.5-25.0	MUDSTONE	760	130	
AB-C-3	43.1-44.0	SANDSTONE	3,982	146	
AB-C-3	43.1-44.0	SANDSTONE	3,983	146	
AB-C-3	45.2-45.8	SANDSTONE	3,113		3.96E+05
AB-C-3	54.5-55.2	SANDSTONE	1,771	143	
AB-C-3	66.4-67.4	MUDSTONE	247	. 139	
AB-C-4	18.0-18.7	MUDSTONE	295	138	,

AB-C-4	24.6-26.1	MUDSTONE	2,117 .	143	
AÉ-C-4	31.0-32.5	SANDSTONE	902	145	
AB-C-4	40.5-41.3.	SANDSTONE	2,918	137	·
AB-C-4	45.7-47.2	SANDSTONE	2,683	126	
AB-C-4	51.3-52.1	SANDSTONE	3,178	152	
AB-C-4	66.2-67.4	MUDSTONE	501	143	
AB-C-5	207.4-208.2	SANDSTONE	4,616		
AB-C-5	218.1-219.0	SANDSTONE	2,863	150	
AB-C-5	333.4-334.2	SANDSTONE	5,077	151	
AB-C-5	337.1-337.7	SANDSTONE	2,966	143	
AB-C-5	339.1-340.2	CONGLOM.	3,214	144	
AB-C-5	342.7-343.3	SANDSTONE	4,116	147	
AB-C-5	348.9-349.6	SANDSTONE	3,814	141	
AB-C-7	107.2-108.1	SANDSTONE	6,899	153	
AB-C-7	132.1-132.6	SANDSTONE	1,745	154	
AB-C-7	251.6-252.3	SANDSTONE	2,573	129	
AB-C-7	254.0-255.0	SANDSTONE	2,140	144	
AB-C-7	268.5-269.2	SANDSTONE	2,664	. 141	
AB-C-8	26.3-27.0	SILTSTONE	4,700	140	
AB-C-8	124.6-125.6	SANDSTONE	1,556	130	
AB-C-8	135.0-135.8	SANDSTONE	1,994	128	**
AB-C-8	146.0-147.2	SANDSTONE	1,464	132	
AB-C-8	149.2-150.1	MUDSTONE	1,001	143	
AB-C-9	34.8-35.8	SANDSTONE	1,414	125	عفق حجل عجل
AB-C-9	36.5-38.2	SANDSTONE	1,992	125	
ÅB-C-9	41.0-42.0	SANDSTONE	5,104	155	
AB-C-9	45.3-46.0	MUDSTONE	707	146	

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### ABIQUIU ADITS ROCK CORE SWELL AND SWELL PRESSURE TESTS

HOLE NUMBER	DEPTH	DRY DENSITY (PCF)	OF SWELL		SWELL CONTROL PRESSURE (TSF)
AB-C-1	184.2 - 185.7	132.9	2.2	0.1	FREE
AB-C-1	184.2 - 185.7	133.1	1.1	0.1	2.7
AB-C-1	257.4 - 258.5	133.8	2.1	0.1	FREE
AB-C-1	257.4 - 258.5	133.6	1.2	0.1	2.0
AB-C-2	128.6 - 129.9	141.0	1.9.	0.1	FREE
AB-C-2	128.6 - 129.9	142.9.	1.1	0.1	1.8
AB-C-2	233.7 - 234.7	124.9	2.6	0.1	FREE
ABC-2	233.7 - 234.7	123.8	1.4	0.1	5
AB-C-2	263.5 - 264.5	145.3	1.5	0.1	FREE
AB-C-2	263.5 - 264.5	144.2	0.7	0.1	3.2
AB-C-3	66.4 - 67.4	134.1	1.1.	0.1	FREE
AB-C-4	18.0 - 18.7	132.6	0.6	0.1	FREE
AB-C-4	66.2 - 67.4	140.2	0.5	0.1	FREE
AB-C-4	66.2 - 67.4	141.7	0.8	0.1	0.9
AB-C-7	268.5 - 269.2	151.3	0.9	0.1	FREE
AB-C-8	149.2 - 150.1	142.8	1.4	0.1	FREE
AB-C-8	26.3 - 27.0	129.6	2.5	0.1	FREE
AB-C-9	45.3 - 46.0	141.3	0.8	0.1	FREE
AB-C-9	57.4 - 59.0	139.8	.1.0	0.1	FREE
AB-C-9	57.4 - 59.0	141.1	0.5	0.1	2.2

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## APPENDIX 3

SEEPAGE FLOWS VERSUS LAKE LEVELS DURING CONSTRUCTION OF ADITS

## POOL LEVEL VERSUS ADIT DISCHARGE

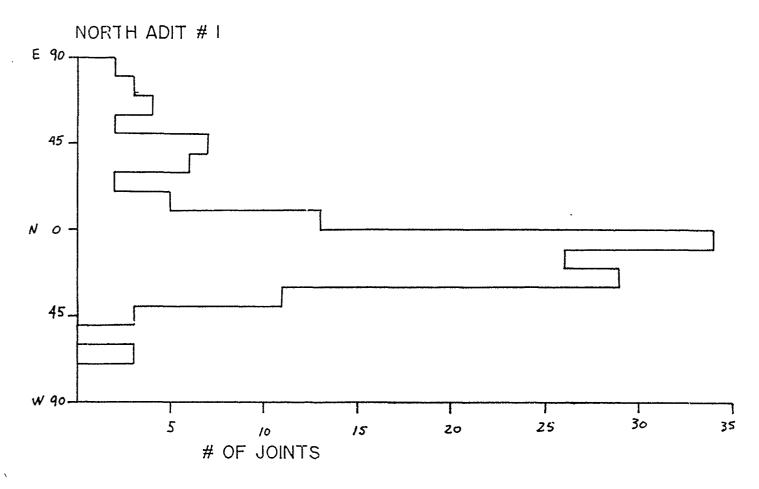
		Pool	South	North
		Elevation	Discharge	Discharge
	<u>Date</u>	<u>(Ft.)</u>	(Gal/Min)	Gal/Min)
		(0.10.40		
	August 14, 1989	6213.68	220	<del>_</del>
	August 15, 1989	6213.65	220	
	August 16, 1989	6213.73	220	-
	August 17, 1989	6213.74	220	_
	August 18, 1989	6213.65	220	
	August 19, 1989	6213.64	220	_
	August 21, 1989	6213.61	220	
	August 22, 1989	6212.75	240	
	August 23, 1989	6212.10	230	
	August 24, 1989	6212.01	220	
	August 25, 1989	6211.05	230	<b></b>
	August 28, 1989	6212.01	230	_
	August 29, 1989	6211.74	220	_
	August 30, 1989	6211.58	220	<del></del>
	August 31, 1989	6211.40	230	
	<b>3</b> -			_
	September 5, 1989	6210.56	280	
	September 6, 1989	6210.54	300	
	September 7, 1989	6210.57	300	_
	September 8, 1989	6210.54	300	-
	September 9, 1989	6210.75	320	
	September 11, 1989	6210.48	300	50 <del>0</del>
	September 12, 1989	6210.53	300	500
Α	September 13, 1989	6210.54	300	520
	September 14, 1989	6210.78	300	500
	September 15, 1989	6210.51	300	500
	September 18, 1989	6210.61	240	500
		6210.71	300	520
	September 19, 1989			
	September 20, 1989	6210.61	300	520
	September 21, 1989	6210.51	300	550
	September 22, 1989	6210.48	300	550
	September 25, 1989	6210.47	300	550
	September 26, 1989	6210.59	300	540
	September 27, 1989	6210.54	300	550
	September 28, 1989	6210.78	300	520
	September 29, 1989	6210.85	300	520
	Ostobor 2 1000	(211.02	200	540
	October 2, 1989	6211.03	300	540
	October 3, 1989	6211.24	300	540
	October 4, 1989	6211.45	3,00	540
	October 5, 1989	6211.48	300	540
	October 6, 1989	6211.45	300	520
	October 7, 1989	6211.47	300	520
	October 9, 1989	6211.48	300	520
	October 10, 1989	6211.42	300	520
_	October 11, 1989	6211.40	300	550
В	October 20, 1989	6211.61	300	540
	October 23, 1989	6211.75	300	540

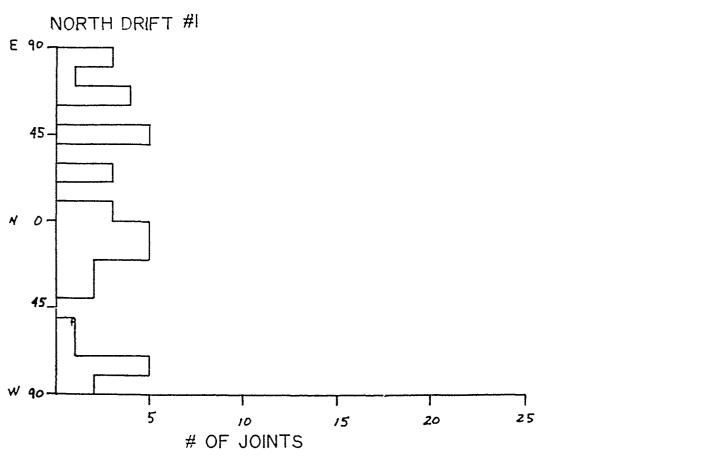
## POOL LEVEL VERSUS ADIT DISCHARGE (Continued)

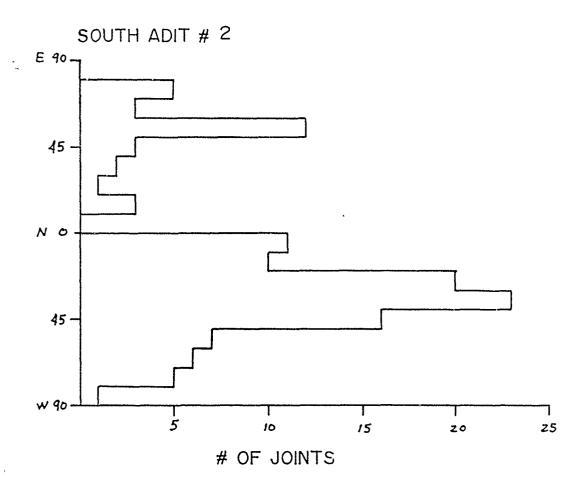
	<u>Date</u>	Pool Elevation (Ft.)	South Discharge (Gal/Min)	North Discharge <u>Gal/Min)</u>
	November 6, 1989 November 8, 1989 November 15, 1989 November 16, 1989	6211.89 6211.93 6212.00 6212.15	300 300 300 300 300	540 540 540 540
	November 20, 1989	6212.21	300	540
	November 27, 1989	6212.48	300	540
	November 29, 1989	6212.55	300	540
С	December 11, 1989	6212.89	310	540
	December 12, 1989	6212.85	310	540
	December 15, 1989	6212.86	310	540
	December 22, 1989	6212.84	310	540
D	January 2, 1990	6212.90	310	540
	January 9, 1990	6212.85	310	540
	January 11, 1990	6212.83	310	540
	January 16, 1990	6212.87	310	540
	January 18, 1990	6212.85	310	540
	January 19, 1990	6212.85	310	540
~	Junuary 17, 1770	0212.03	310	340

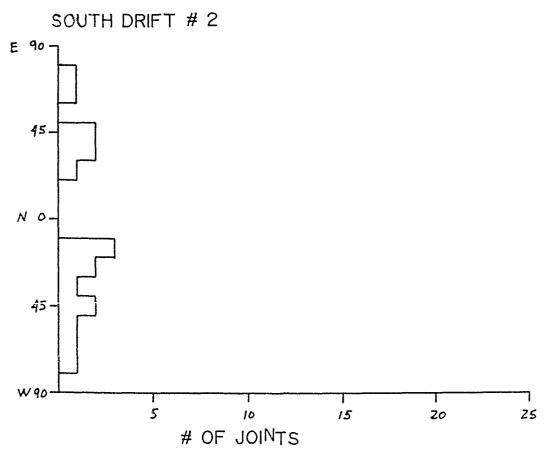
<sup>A - South Adit and Drift Completed
B - North Adit and Drift Completed
C - South Side Drainholes Completed
D - North Side Drainholes Completed</sup> 

# APPENDIX 4 JOINT ORIENTATION DIAGRAMS









# APPENDIX 5 CHRONOLOGICAL RECORD OF DRILLING PROGRAM

## CHRONOLOGICAL RECORD OF DRILLING PROGRAM

<u>Date</u>	Station	Direction	Depth (Ft.)	Orientation
October 5-9 1989	0+20 South Drift	Uphole	147	Vertical
October 10-11, 1989	0+40 South Drift	Uphole	147	Vertical
October 12, 1989	0+60 South Drift	Uphole	147	Vertical
October 13-14, 1989	0+80 South Drift	Uphole	147	Vertical
October 14-16, 1989	1+00 South Drift	Uphole	146	Vertical
October 18, 1989	1+20 South Drift	Uphole	146	Vertical
October 19, 1989	1+40 South Drift	Uphole	146	Vertical
October 19-20, 1989	1+60 South Drift	Uphole	147	Vertical
October 20-21, 1989	1+80 South Drift	Uphole	145	Vertical
October 23, 1989	2+00 South Drift	Uphole	145	Vertical
	2+00 South Drift	Downhole	12	Vertical
	1+80 South Drift	Downhole	12	Vertical
	1+60 South Drift	Downhole	12	Vertical
	1+40 South Drift	Downhole	12	Vertical
	1+20 South Drift	Downhole	12	Vertical
October 24, 1989	1+00 South Drift	Downhole	12	Vertical
	0+80 South Drift	Downhole	12	Vertical
	0460 South Drift	Downhole	12	Vertical
	0+40 South Drift	Downhole	12	Vertical
	0+20 South Drift	Downhole	12	Vertical
October 24-25, 1989	4+30	Uphole	118	Vertical
October 25, 1989	4+50	Uphole	118	Vertical
October 26, 1990	5+20 South Adit			
	No. 6	Downhole	20	Inclined
	No. 7	Downhole	38	Inclined
	No. 8	Downhole	57	Inclined
October 27, 1989	No. 9	Downhole	77	Inclined
	No. 10	Downhole	97	Inclined
October 28-30, 1989	No. 14	Uphole	142	Inclined
	No. 22	Downhole	117	Inclined
	No. 1	Uphole	149	Inclined
	No. 17	Downhole	20	Inclined
October 31, 1989	No. 18	Downhole	38	Inclined
	No. 20	Downhole	77	Inclined
November 1, 1989	No. 21	Downhole	97	Inclined
November 3-6, 1989	2+50 South Adit	Uphole	55	Vertical
	2+70 South Adit	Uphole	55	Vertical
	5+20 South Adit	<b>60 00</b>		
	No. 2	Uphole	153	Inclined

## CHRONOLOGICAL RECORD OF DRILLING PROGRAM

<u>Date</u>	<u>Station</u>	<b>Direction</b>	Depth (Ft.)	<u>Orientation</u>
November 7-8, 1989	2+90 South Adit	Uphole	55	Vertical
	5+70 South Adit	Uphole	147	Vertical
November 8-9, 1989	5+90 South Adit	Uphole	147	Vertical
	3+10 South Adit	Uphole	119	Vertical
	3+30 South Adit	Uphole	119	Vertical
November 10, 1989	6+10 South Adit	Uphole	146	Vertical
	3+50 South Adit	Uphole	119	Vertical
November 11-14, 1989	5+50 South Adit	Uphole	146	Vertical
	4+10 South Adit	Uphole	118	Vertical
	3+70 South Adit	Uphole	119	Vertical
	3+90 South Adit	Uphole	119	Vertical
	6+30 South Adit	Uphole	146	Vertical
November 14-15, 1989	6+50 South Adit	Uphole	146	Vertical
	6+70 South Adit	Uphole	146	Vertical
	5+20 South Adit			
	No. 3 South Adit	Uphole	159	Inclined
	No. 4 South Adit	Uphole	168	Inclined
	No. 5 South Adit	Uphole	178	Inclined
November 15-16, 1989	6+90 South Adit	Uphole	145	Vertical
	2+00 South Drift			
	No. 1	Uphole	148	Inclined
	5+20 South Adit			
	No. 11	Uphole	149	Incl.ned
November 16-17, 1989	2+00 South Drift			
	No. 2	Uphole	152	Inclined
	7+10 South Adit	Uphole	145	Vertical
	7+30 South Adit	Uphole	145	Vertical
	5+20 South Adit		٠	
	No. 12	Uphole	145	Vertical
	5+30 South Adit	Uphole	147	Vertical
November 17-18, 1989	7+50 South Adit	Uphole	144	Vertical
	7+70 South Adit	Uphole	144	Vertical
November 18-20, 1989	7+90 South Adit	Uphole	144	Vertical
	5+20 South Adit		and com-	
	No. 15	Uphole	154	Inclined
	No. 16	Uphole	167	Inclined
	2+00 South Drift			
	No. 3	Uphole	158	Inclined

# CHRONOLOGICAL RECORD OF DRILLING PROGRAM (Continued)

<u>Date</u>	Station	Direction	Depth (Ft.)	Orientation
November 21, 1989	2+00 South Drift	<del>~</del> ~	~	
	No. 4	Uphole	166	Inclined
	No. 5	Uphole	177	Inclined
	8+10 South Adit	Uphole	144	Vertical
November 22, 1990	8+30 South Adit	Uphole	144	Vertical
November 27, 1989	1+90 South Adit	Uphole	144	Vertical
	2+10 South Adit	Uphole	57	Vertical
	2+30 South Adit	Uphole	58	Vertical
	4+70 South Adit	Uphole	146	Vertical
	5+10 South Adit	Uphole	147	Vertical
	8+50 South Adit			
	No. 1	Uphole	146	Inclined
	No. 2	Uphole	150	Inclined
November 28, 1989	8+50 South Adit			
	No. 3	Uphole	156	Inclined
	No. 7	Downhole	44	Inclined
	No. 10	Downhole	99	Inclined
	7+10 South Adit			
	No. 6	Downhole	18	Inclined
	No. 7	Downhole	37	Inclined
	No. 8	Downhole	57	Inclined
	No. 9	Downhole	77	Inclined
	No. 10	Downhole	97	Inclined
November 29, 1989	1+30 South Adit	Uphole	57	Vertical
	1+50 South Adit	Uphole	57	Vertical
	1+70 South Adit	Uphole	57	Vertical
	8+50 South Adit			
	No. 4	Uphole	165	Inclined
	7+10 South Adit			~ ·
	No. 1	Uphole	147	Inclined

# CHRON JICAL RECORD OF DRILLING PROGRAM (Continued)

Date	Station	Direction	Depth (Ft.)	<u>Orientation</u>
November 30, 1989	0+90 South Adit	Uphole	25	Vertical
	0+90 South Adit			
	No. 1	Uphole	16	Inclined
	No. 2	Uphole	36	Inclined
	No. 3	Uphole	16	Inclined
	1+10 South Adit	Uphole	25	Vertical
	8+50 South Adit	Uphole	144	Vertical
	8+50 South Adit			
	No. 5	Uphole	175	Inclined
	0+90 South Adit			
	No. 4	Uphole	36	Inclined
	No. 5	Uphole	56	Inclined
December 1-2, 1989	3+90 Soutn Adit	Downhole	15	Vertical
	4+10 South Adit	Downhole	15	Vertical
	4+30 South Adit	Downhole	15	Vertical
	4+50 South Adit	Downhole	15	Vertical
	4+70 South Adit	Downhole	15	Vertical
	4+90 South Adit	Downhole	15	Vertical
	5+10 South Adit	Downhole	15	Vertical
	5+30 South Adit	Downhole	15	Vertical
	5+50 South Adit	Downhole	15	Vertical
	5+70 South Adit	Downhole	15	Vertical
	5+90 South Adit	Downhole	15	Vertical
	6+10 South Adit	Downhole	15	Vertical
	6+30 South Adit	Downhole	15	Vertical
	7+10 South Adit			
	No. 4	Uphole	144	Inclined
	No. 5	Uphole ·	156	Inclined
	8+50 South Adit	Uphole	146	Vertical
December 4-5, 1989	4+90 South Adit	Uphole	118	Vertical
	8+50 South Adit			
	No. 8	Downhole	62	Inclined
	No. 9	Downhole	80	Inclined
	6+70 South Adit	Downhole	15	Vertical
	6+90 South Adit	Downhole	15	Vertical
	0+90 South Adit	Downhole	10	Vertical
	1+10 South Adit	Downhole	10	Vertical
	1+30 South Adit	Downhole	10	Vertical

<u>Date</u>	Station	Direction	Depth (Ft.)	Orientation
December 4-5, 1989	1+50 South Adit	Downhole	10	Vertical
	1+70 South Adit	Downhole	10	Vertical
	1+90 South Adit	Downhole	10	Vertical
	2+10 South Adit	Downhole	10	Vertical
	2+30 South Adit	Downhole	10	Vertical
	2+50 South Adit	Downhole	10	Vertical
	2+70 South Adit	Downhole	10	Vertical
	2+90 South Adit	Downhole	10	Vertical
	3+10 South Adit	Downhole	10	Vertical
	3+30 South Adit	Downhole	10	Vertical
	3+50 South Adit	Downhole	10	Vertical
	3+70 South Adit	Downhole	10	Vertical
December 6-9, 1989	7+10 South Adit	Downhole	20	Vertical
	7+30 South Adit	Downhole	20	Vertical
	7+50 South Adit	Downhole	20	Vertical
	7+70 South Adit	Downhole	20	Vertical
	7+90 South Adit	Downhole	20	Vertical
	8+10 South Adit	Downhole	20	Vertical
	8+30 South Adit	Downhole	20	Vertical
	8+50 South Adit	Downhole	20	Vertical
	7+30 North Adit	Downhole	25	Vertical
	7+50 North Adit	Downhole	25	Vertical
	7+70 North Adit	Downhole	25	Vertical
	7+90 North Adit	Downhole	25	Vertical
	8+10 North Adit	Downhole	25	Vertical
	8+30 North Adit	Downhole	25	Vertical
	8+50 North Adit	Downhole	25	Vertical
	8+70 North Adit	Downholè	25	Vertical
	8+90 North Adit	Downhole	28	Vertical
	9+10 North Adit	Downhole	28	Vertical
	9+30 North Adit	Downhole	28	Vertical
	9+50 North Adit	Downhole	28	Vertical
	9+70 North Adit	Downhole	30	Vertical
	9+90 North Adit	Downhole	30	Vertical
	10+10 North Adit	Downhole	30	Vertical
	10+30 North Adit	Downhole	30	Vertical
	10150 North Adit	Downhole	30	Vertical
	10+70 North Adit	Downhole	30	Vertical
				, or trout

<u>Date</u>	<u>Station</u>	Direction	Depth (Ft.)	Orientation
December 6-9, 1989	8+50 South Adit			
	No. 6	Downhole	29	Inclined
	7+10 South Adit			
	No. 2	Uphole	151	Inclined
	No. 3	Uphole	135	Inclined
	5+20 South Adit			
	No. 13	Uphole	132	Inclined
	No. 19	Uphole	57	Inclined
	2+80 North Drift	Downhole	23	Vertical
	3+00 North Drift	Downhole	23	Vertical
	3+10 North Drift	Downhole	23	Vertical
	3+20 North Drift	Downhole	23	Vertical
	3+40 North Drift	Downhole	23	Vertical
	3+60 North Drift	Downhole	23	Vertical
December 11-12, 1989	7+10 South Adit			
	No. 4	Uphole	144	Inclined
	No. 5	Uphole	156	Inclined
	0+60 North Drift	Downhole	22	Vertical
	0+80 North Drift	Downhole	22	Vertical
	1+20 North Drift	Downhole	22	Vertical
	1+40 North Drift	Downhole	23	Vertical
	1+60 North Drift	Downhole	23	Vertical
	1+80 North Drift	Downhole	23	Vertical
	2+00 North Drift	Downhole	23	Vertical
	2+20 North Drift	Downhole	23	Vertical
	2+40 North Drift	Downhole	23	Vertical
	2+60 North Drift	Downhole	23	Vertical
	5+50 North Adit	Downhole	25	Vertical
	5+70 North Adit	Downhole	25	Vertical
	5+90 North Adit	Downhole	25	Vertical
	6+10 North Adit	Downhole	25	Vertical
	6+30 North Adit	Downhole	25	Vertical
	6+50 North Adit	Downhole	25	Vertical
December 11-12, 1989	6+70 North Adit	Downhole	25	Vertical
	6+90 North Adit	Downhole	25	Vertical
	7+10 North Adit	Downhole	25	Vertical

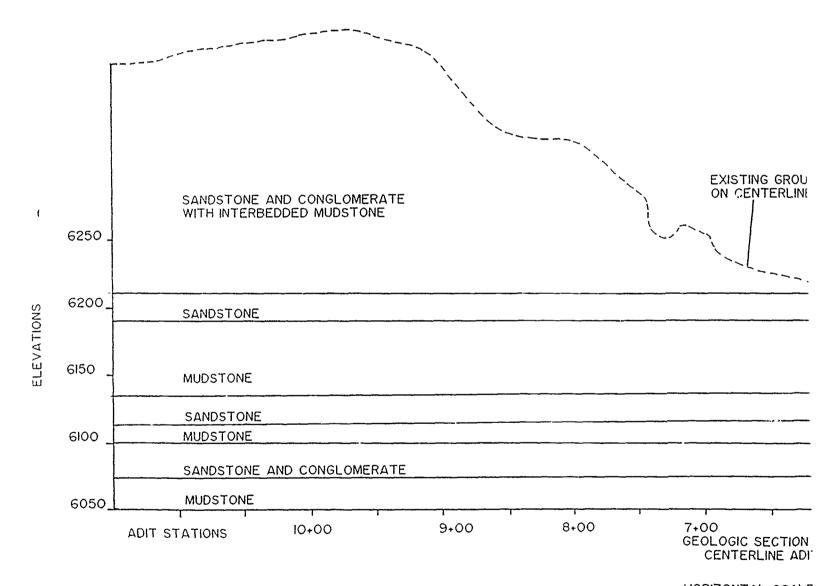
<u>Date</u>	<u>Station</u>	Direction	Depth (Ft.)	<b>Orientation</b>
December 13-14, 1989	0+20 North Drift	Uphole	35	Vertical
	0+40 North Drift	Uphole	35	Vertical
	2+90 North Adit	Uphole	33	Vertical
	3+10 North Adit	Uphole	58	Vertical
	3+30 North Adit	Downhole	20	Vertical
	3+50 North Adit	Downhole	20	Vertical
	3+70 North Adit	Downhole	20	Vertical
	3+90 North Adit	Downhole	20	Vertical
	4+10 North Adit	Downhole	25	Vertical
	4+30 North Adit	Downhole	25	Vertical
	4+50 North Adit	Downhole	25	Vertical
	4+70 North Adit	Downhole	25	Vertical
	4+90 North Adit	Downhole	25	Vertical
	5+10 North Adit	Downhole	25	Vertical
	5+30 North Adit	Downhole	25	Vertical
December 15, 1989	0+60 North Drift	Uphole	58	Vertical
December 16-19, 1989	3+30 North Adit	Uphole	58	Vertical
	3+50 North Adit	Uphole	60	Vertical
	3+70 North Adit	Uphole	58	Vertical
	3+90 North Adit	Uphole	58	Vertical
	2+10 North Adit	Downhole	20	Vertical
	2+30 North Adit	Downhole	20	Vertical
	2+50 North Adit	Downhole	20	Vertical
	2+70 North Adit	Downhole	20	Vertical
	2+90 North Adit	Downhole	20	Vertical
	3+10 North Adit	Downhole	20	Vertical
December 20, 1989	4+10 North Adit	Uphole	59	Vertical
December 21-22, 1989	4+30 North Adit	Uphole	60	Vertical
	4+50 North Adit	Uphole	60	Vertical
	4+70 North Adit	Uphole	58	Vertical
	9+50 North Adit			
	No. 1	Uphole	164	Inclined
	No. 2	Uphole	167	Inclined
	No. 3	Uphole	166	Inclined
December 26-29, 1989	0+80 North Drift	Uphole	173	Inclined

<u>Date</u>	Station	Direction	Depth (Ft.)	Orientation
December 26-29, 1989	1+00 North Drift	Uphole	57	Vertical
	1+20 North Drift	Uphole	57	Vertical
	1+40 North Drift	Uphole	102	Vertical
	3+00 North Drift	Uphole	160	Vertical
	3+20 North Drift	Uphole	160	Vertical
	2+70 North Adit	Uphole	34	Vertical
December 30-January 2,	1+60 North Drift	Uphole	102	Vertical
	1+80 North Drift	Uphole	160	Vertical
	2+00 North Drift	Uphole	160	Vertical
	3+40 North Drift	Uphole	160	Vertical
	3+60 North Drift	Uphole	160	Vertical
	2+10 North Adit	Uphole	35	Vertical
	2+30 North Adit	Uphole	35	Vertical
December 30-January 2	2+50 North Adit	Uphole	36	Vertical
	4+90 North Adit	Uphole	55	Vertical
	5+10 North Adit	Uphole	100	Vertica!
	3+20 North Adit			
	No. 1	Uphole	40	Inclined
	No. 2	Uphole	52	Inclined
	No. 3	Uphole	68	Inclined
	9+50 North Adit			
	No. 4	Uphole	181	Inclined
	No. 5	Uphole	190	Inclined
	No. 6	Uphole	201	Inclined
	3+60 North Drift			
	No. 1	Uphole	162	Inclined
	No. 2	Uphole	165	Inclined
	No. 3	Uphole '	171	Inclined
	No. 4	Uphole	179	Inclined
January 3-4, 1990	2+20 North Drift	Uphole	161	Vertical
	2+40 North Brift	Uphole	161	Vertical
	3+20 North Adit			
	No. 4	Uphole	85	Inclined
	No. 5	Uphole	103	Inclined
	No. 6	Uphole	122	Inclined
	9+50 North Adit			
	No. 7	Uphole	214	Inclined

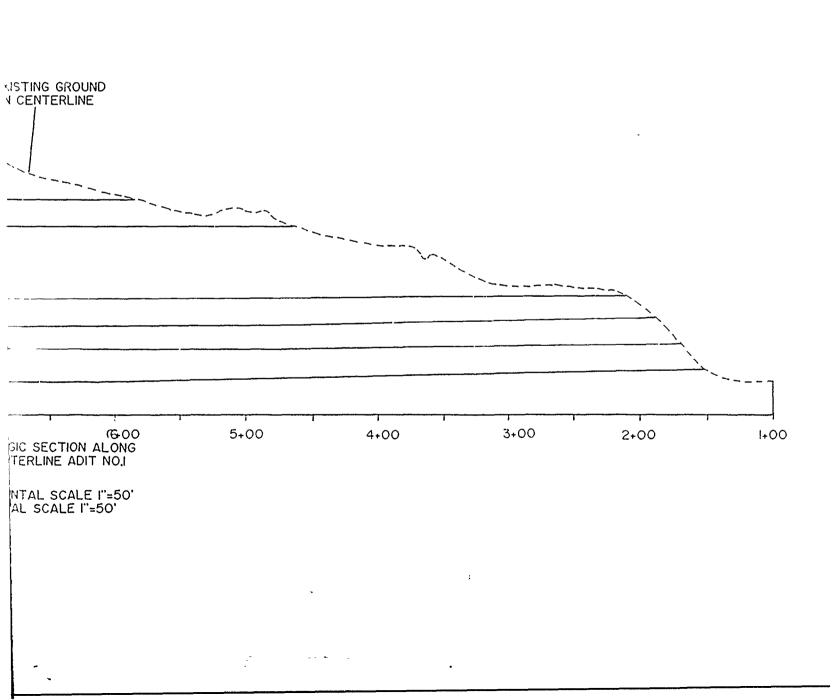
<u>Date</u>	<u>Station</u>	Direction	Depth (Ft.)	Orientation
January 3-4, 1989	3+60 North Drift			
	No. 5	Uphole	189	Inclined
January 5-9, 1989	2+60 North Drift	Uphole	160	Vertical
	2+80 North Drift	Uphole	160	Vertical
	5+30 North Adit	Uphole	101	Vertical
	5+50 North Adit	Uphole	101	Vertical
	5+70 North Adit	Uphole	101	Vertical
	5+90 North Adit	Uphole	101	Vertical
	6+10 North Adit	Uphole	101	Vertical
	9+10 North Adit	Uphole	156	Vertical
	9+30 North Adit	Uphole	156	Vertical
January 10-11, 1990	6+30 North Adit	Uphole	94	Vertical
	7+10 North Adit	Uphole	155	Vertical
	7+30 North Adit	Uphole	156	Vertical
	10+30 North Adit	Uphole	155	Vertical
	9+50 North Adit	Uphole	157	Vertical
	9+70 North Adit	Uphole	157	Vertical
	9+90 North Adit	Uphole	157	Vertical
	10+80 North Adit			
	No. 5	Uphole	185	Inclined
January 12-16, 1990	6+50 North Adit	Uphole	95	Vertical
	6+70 North Adit	Uphole	95	Vertical
	6+90 North Adit	Uphole	95	Vertical
	7+50 North Adit	Uphole	157	Vertical
	7+70 North Adit	Uphole	157	Vertical
	7+90 North Adit	Uphole	156	Vertical
	8+90 North Adit	Uphole	155	Vertical
	10+50 North Adit	Uphole '	155	Vertical
	10+70 North Adit	Uphole	155	Vertical
	10+80 North Adit			
	No. 1	Uphole	158	Inclined
January 12-16, 1990	10+80 North Adit	-		
	No. 2	Uphole	161	Inclined
	No. 3	Uphole	167	Inclined
	No. 4	Uphole	175	Inclined
January 17-18, 1990	8+10 North Adit	Uphole	155	Vertical
•		• •		

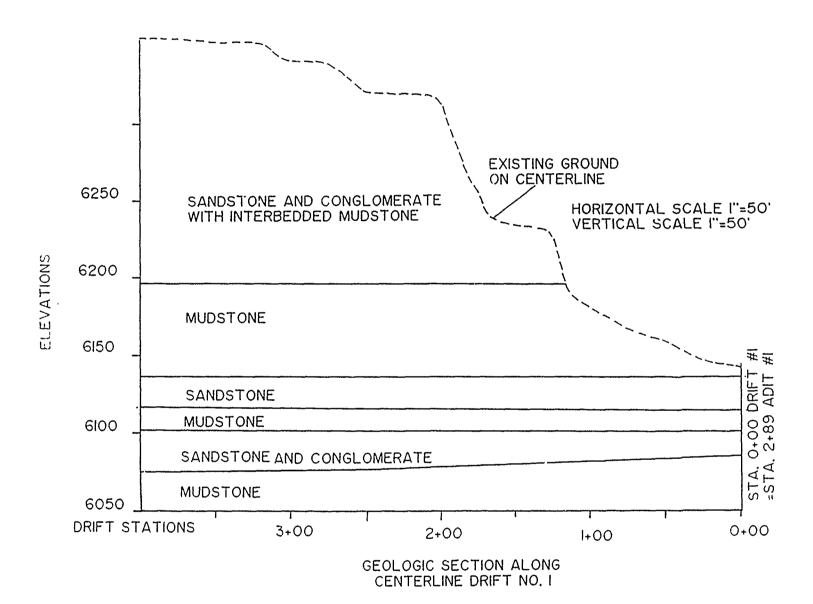
<u>Date</u>	<u>Station</u>	<b>Direction</b>	Depth (Ft.)	<u>Orientation</u>
January 17-18, 1990	10+10 North Adit	Uphole	155	Vertical
	10+30 North Adit	Uphole	155	Vertical
	8+30 North Adit	Uphole	156	Vertical
	8+50 North Adit	Uphole	159	Vertical
	9+30 North Adit	Uphole	155	Vertical
January 19, 1990	9+10 North Adit	Uphole	155	Vertical

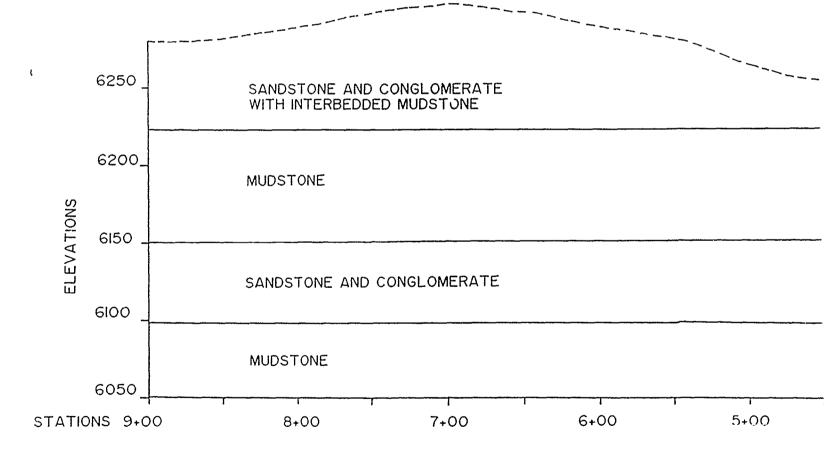
## APPENDIX 6 GEOLOGIC SECTIONS ALONG ADITS AND DRIFTS



HORIZONTAL SCALE VERTICAL SCALE I"

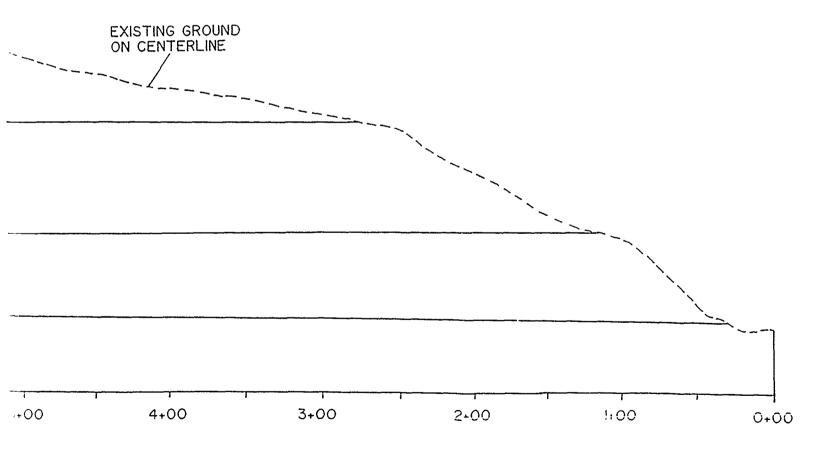




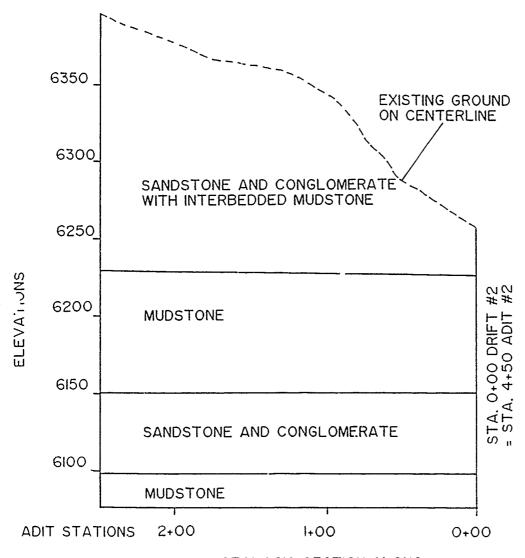


GEOLOGIC SECTION ALONG CENTERLINE ADIT NO. 2 HORIZONTAL SCALE:1"=50' VERTICAL SCALE I"=50'

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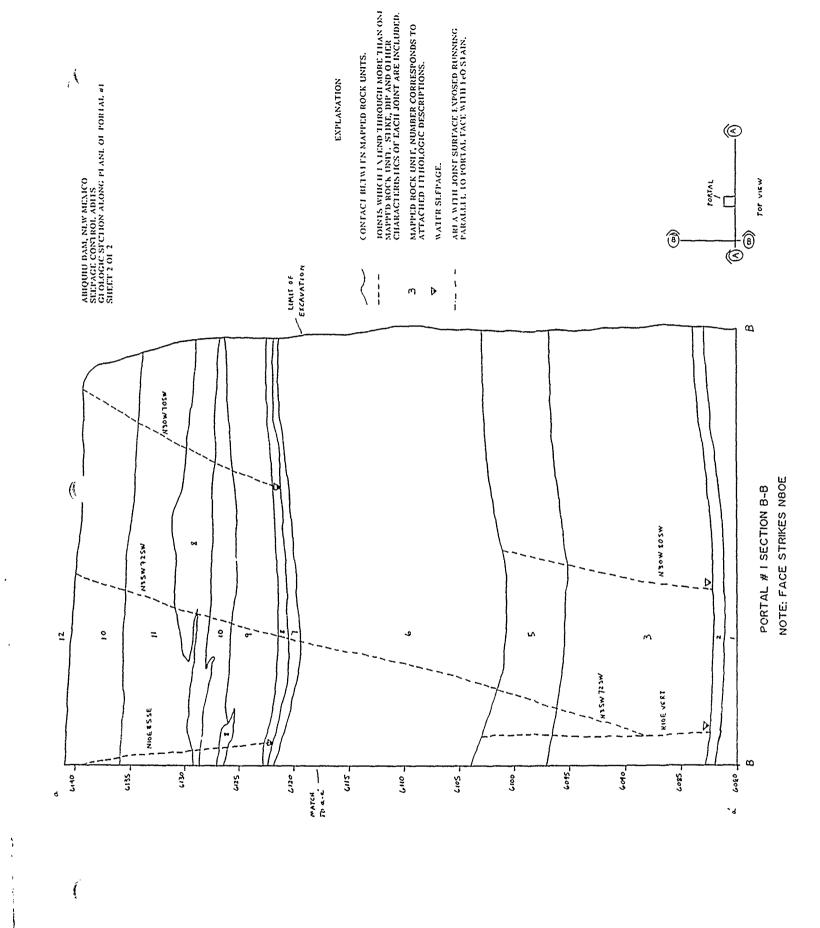
FION ALONG DIT NO. 2 PALE:I"=50' LE I"=50'

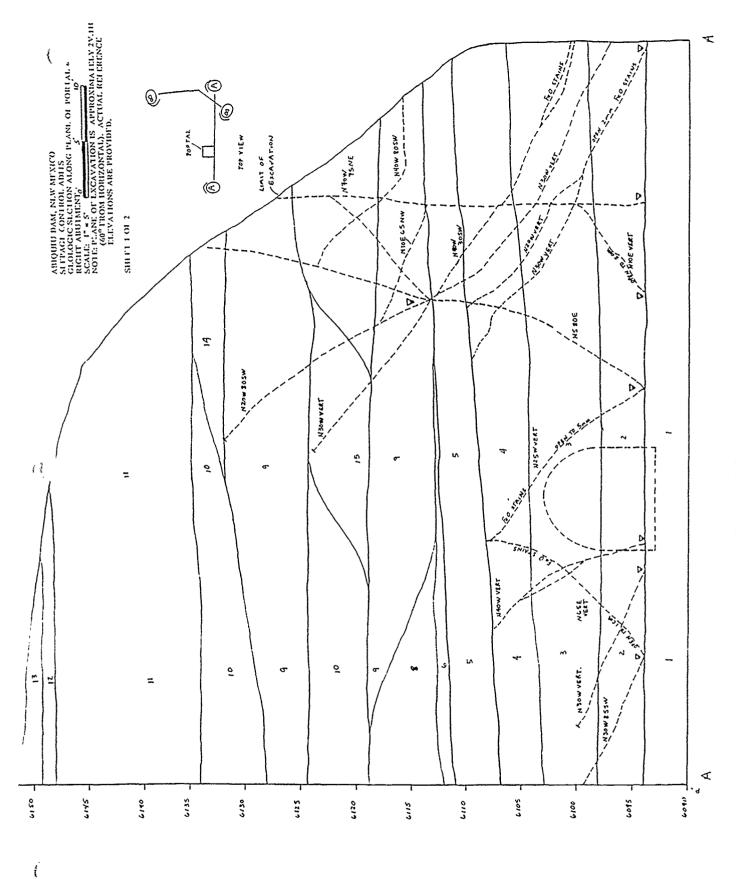


GEOLOGIC SECTION ALONG CENTERLINE DRIFT NO. 2 HORIZONTAL SCALE: I"=50' VERTICAL SCALE: I"=50'

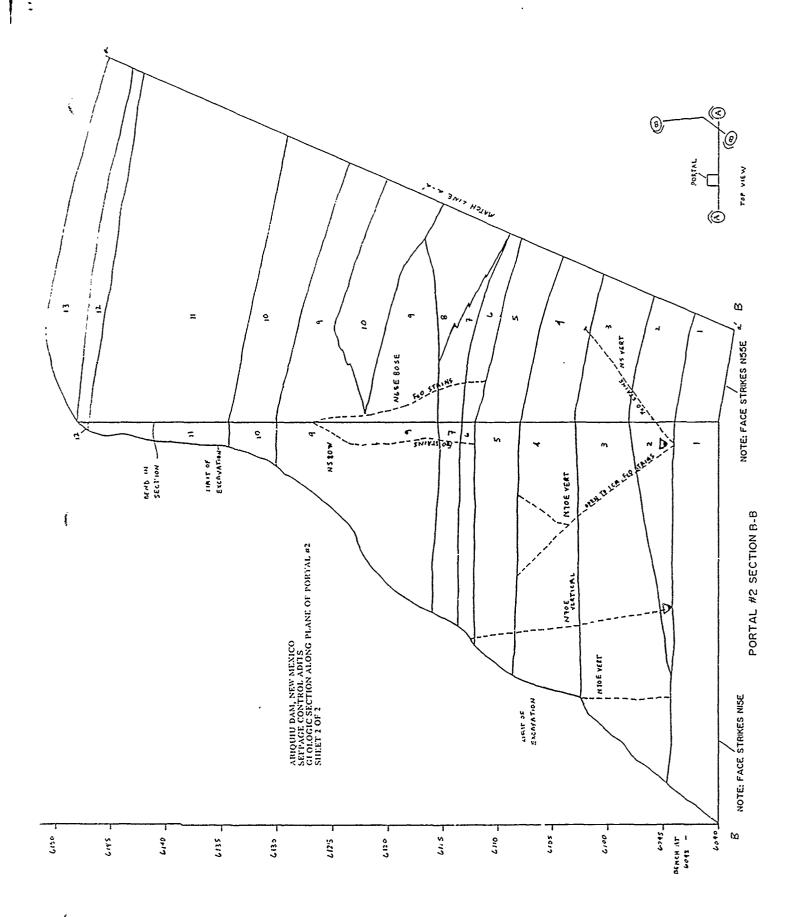
## APPENDIX 7 MAPS OF PORTAL FACES, ADITS AND DRIFTS

PORTAL #1 SECTION A-A NOTE: FACE STRIKES NIOW





PORTAL #2 SECTION A - A NOTE: FACE STRIKES N70W

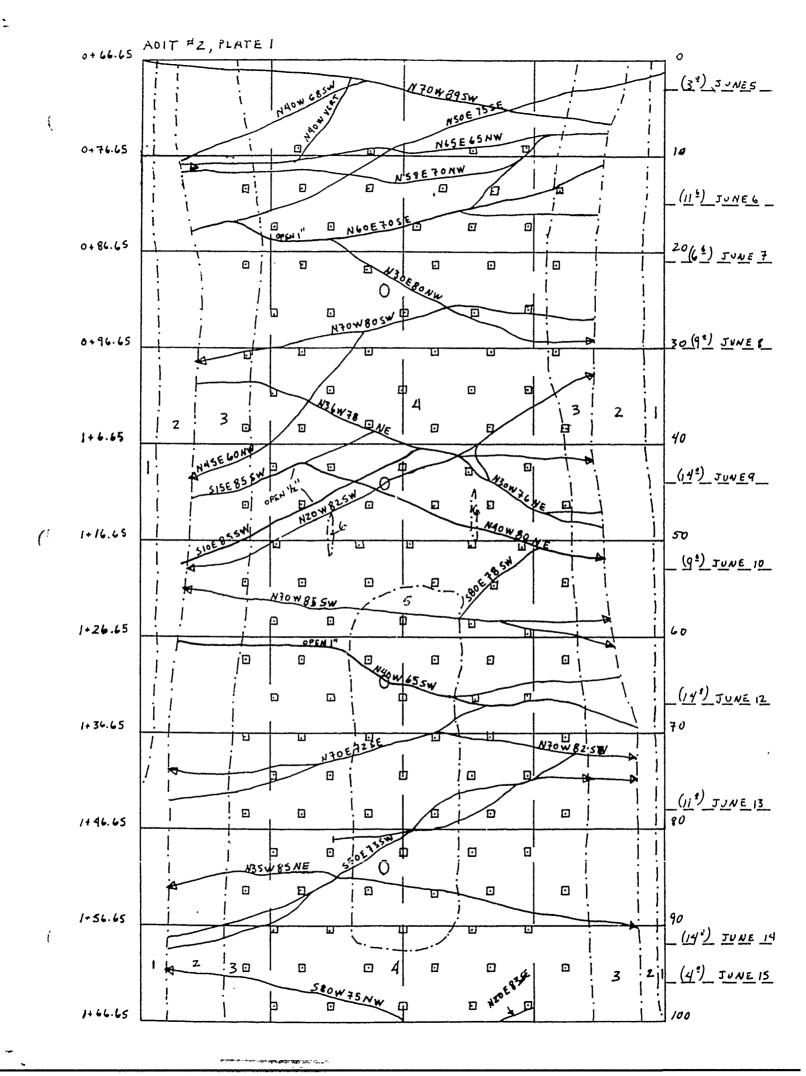


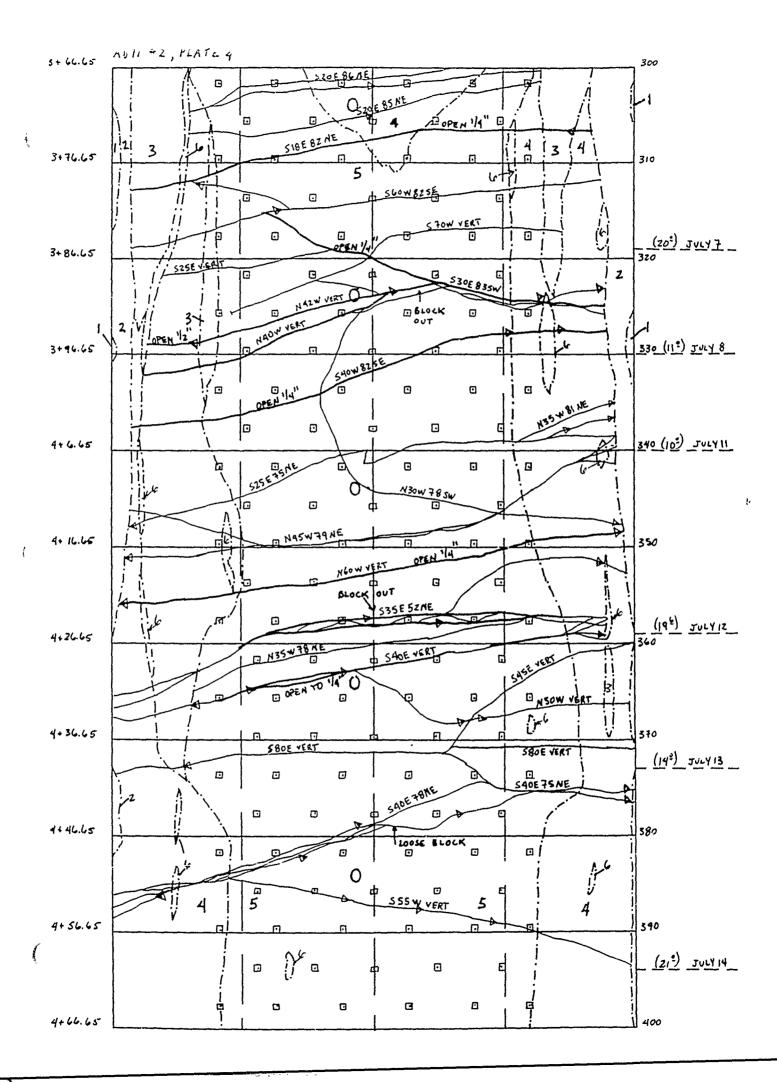
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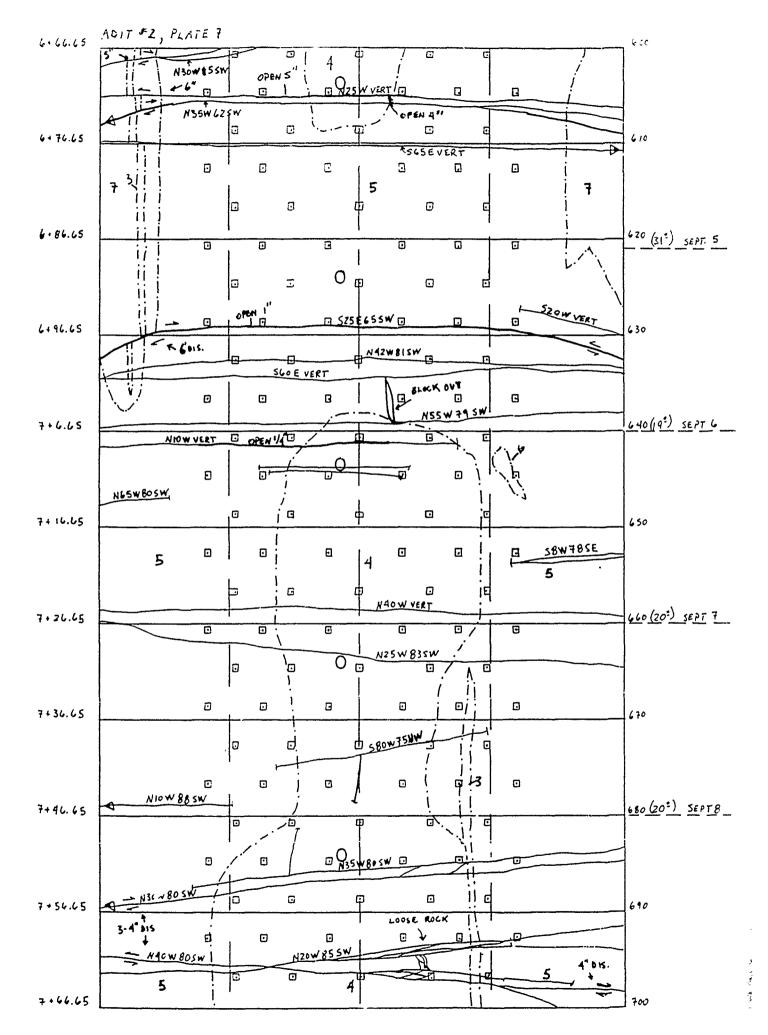
#### LEGEND

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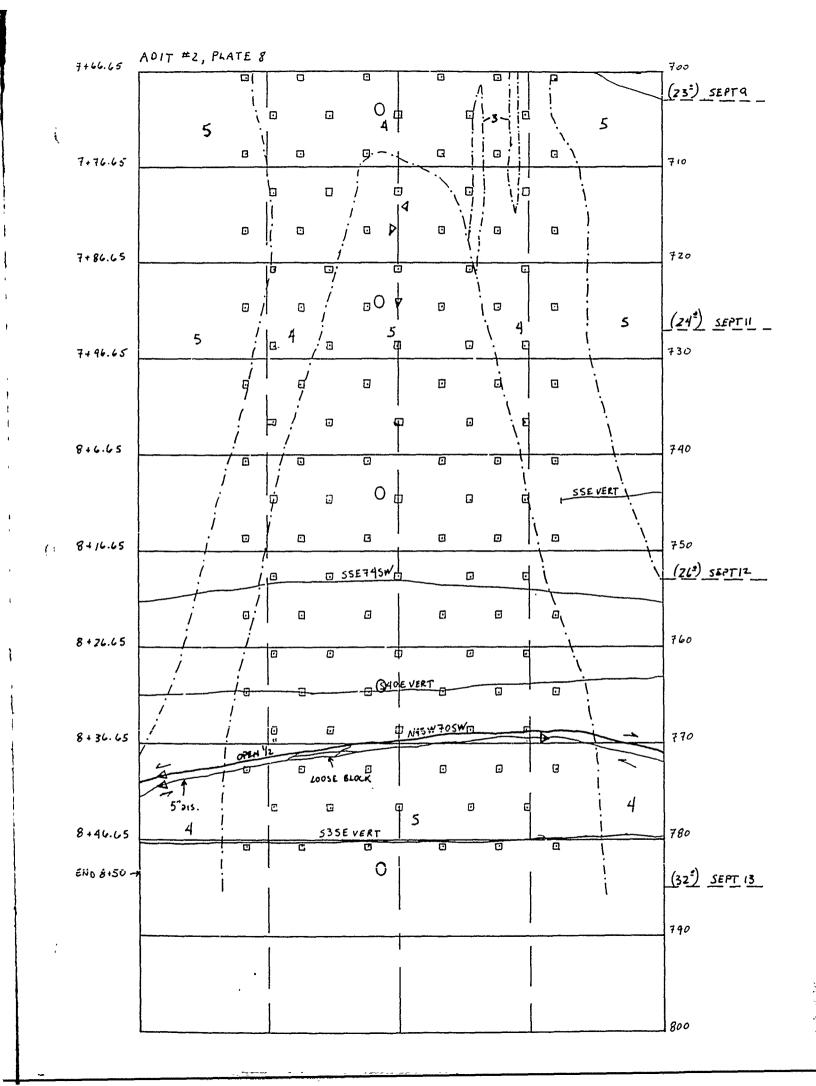
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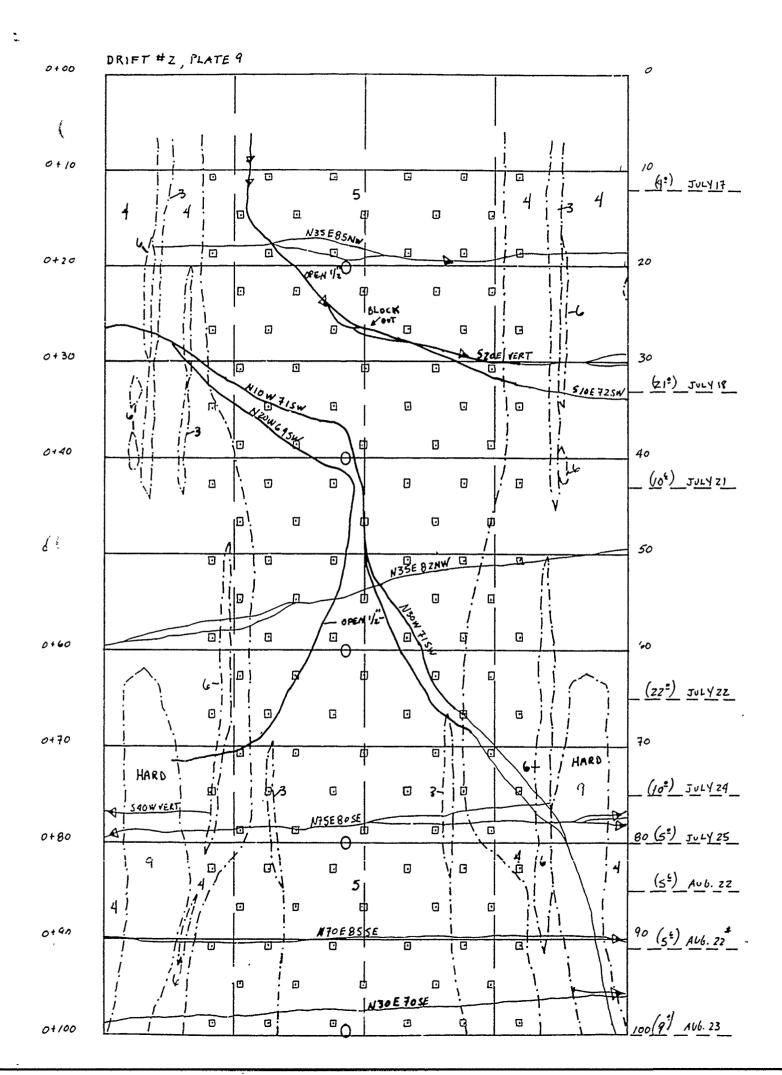


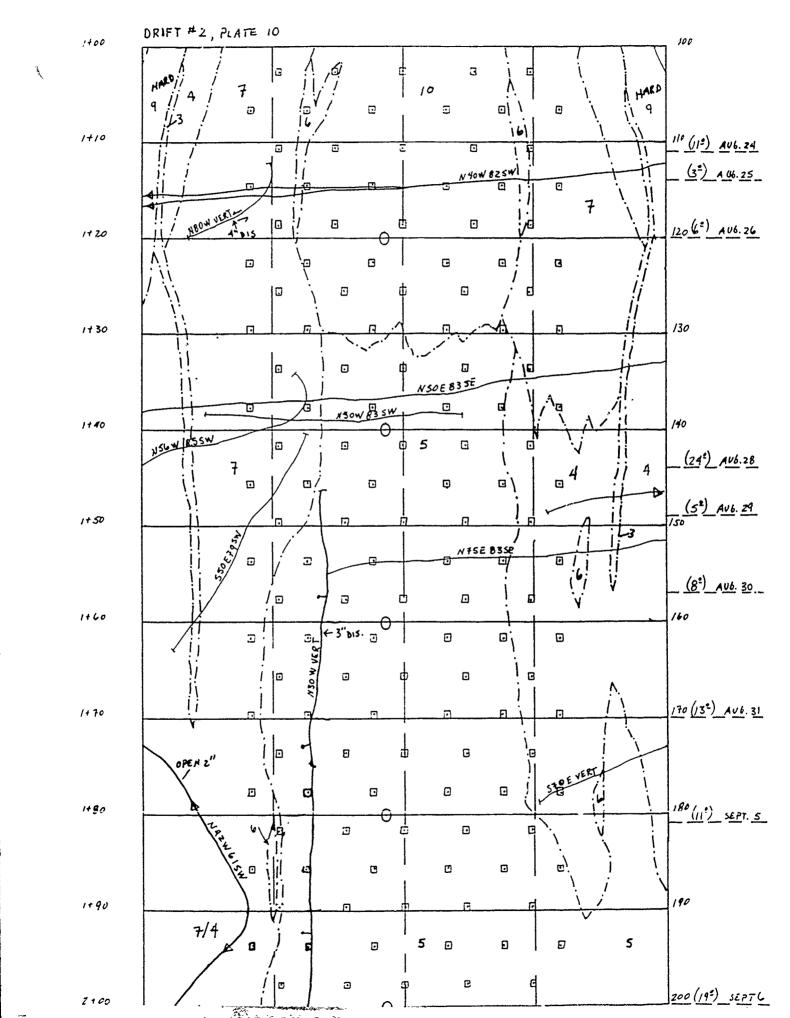




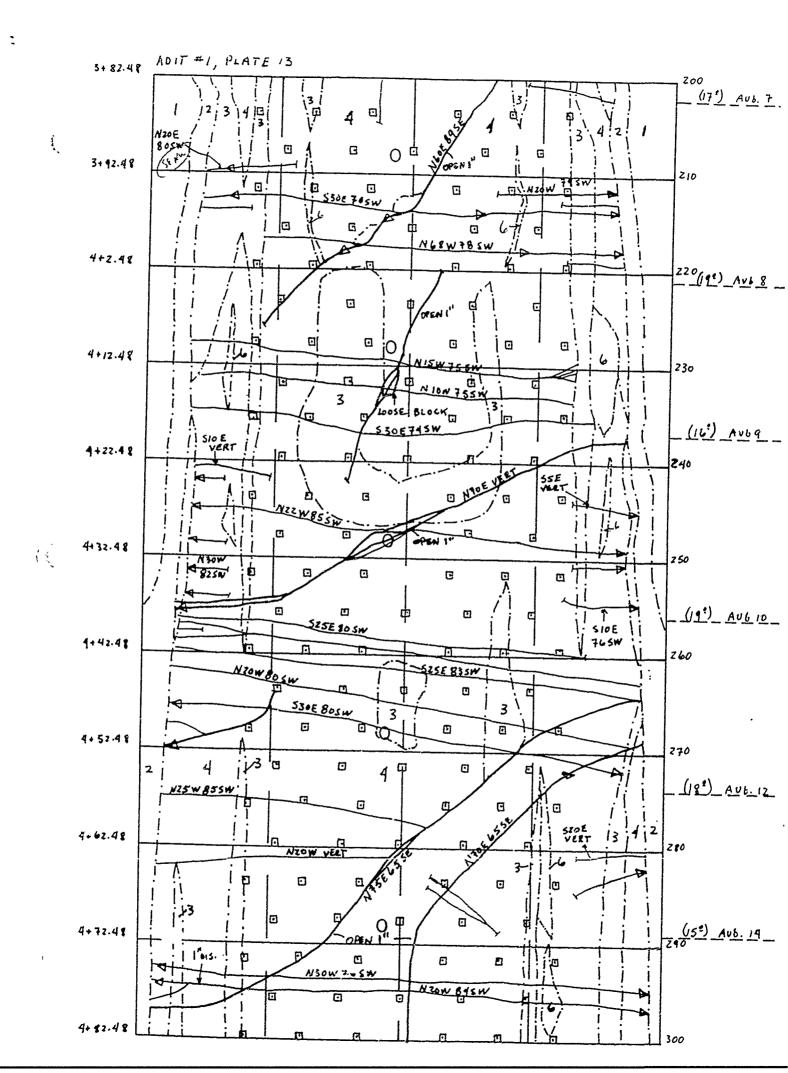
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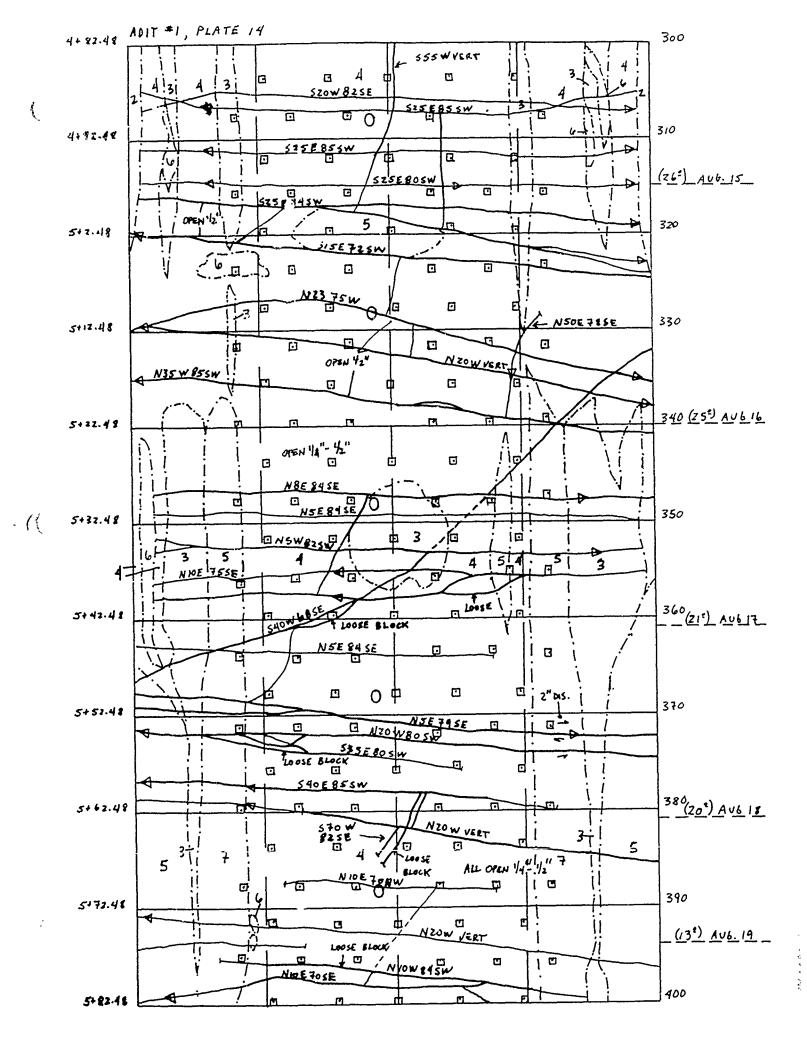




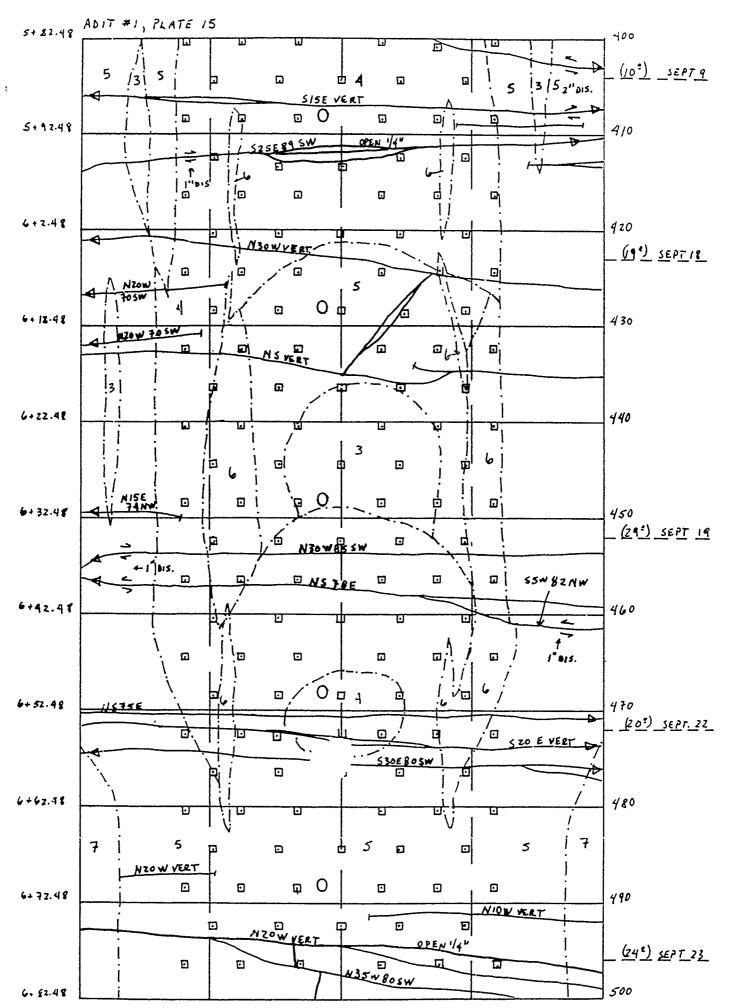


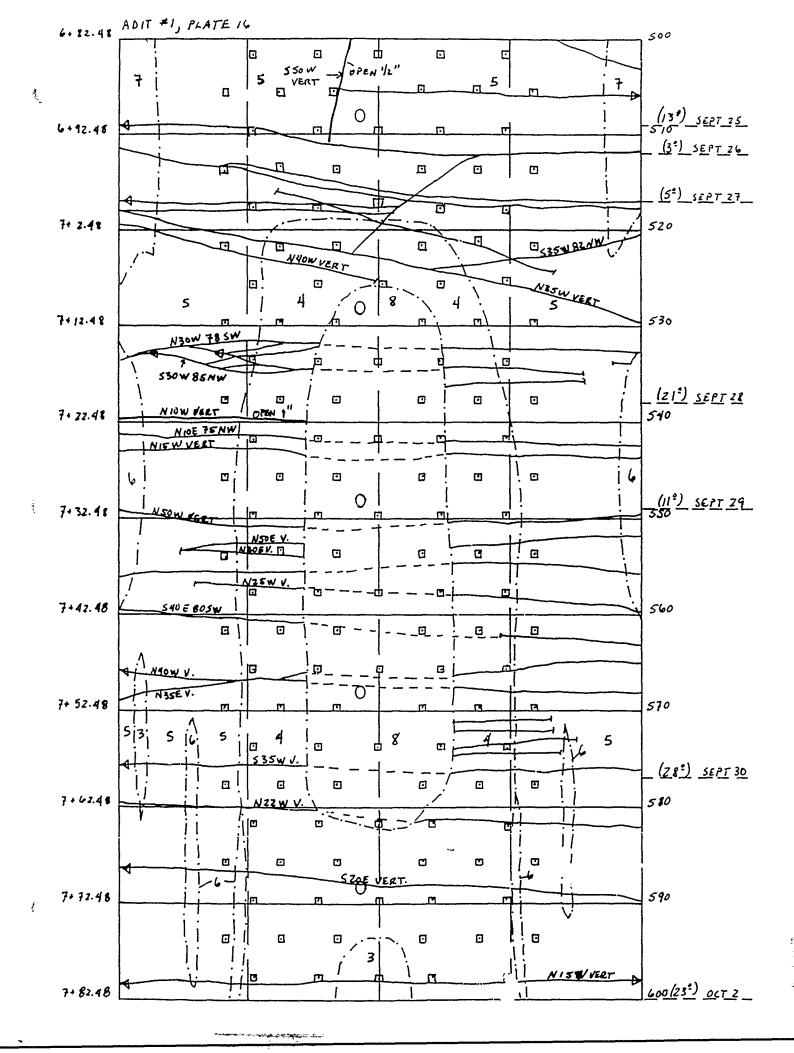
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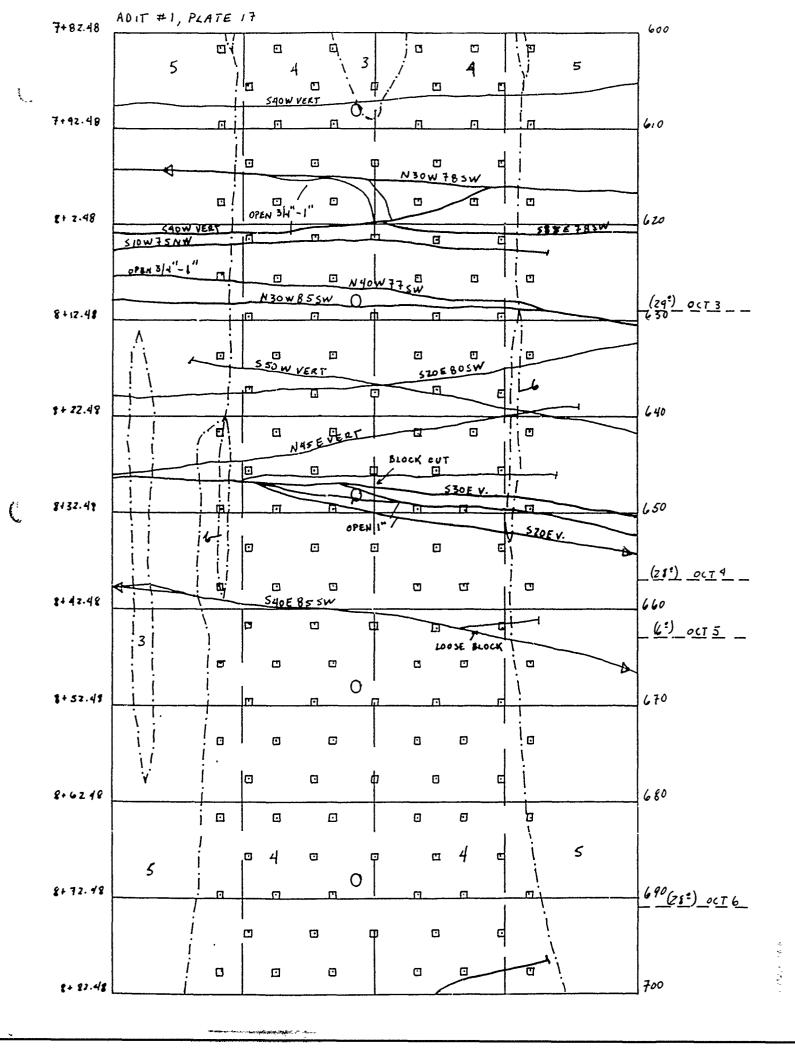


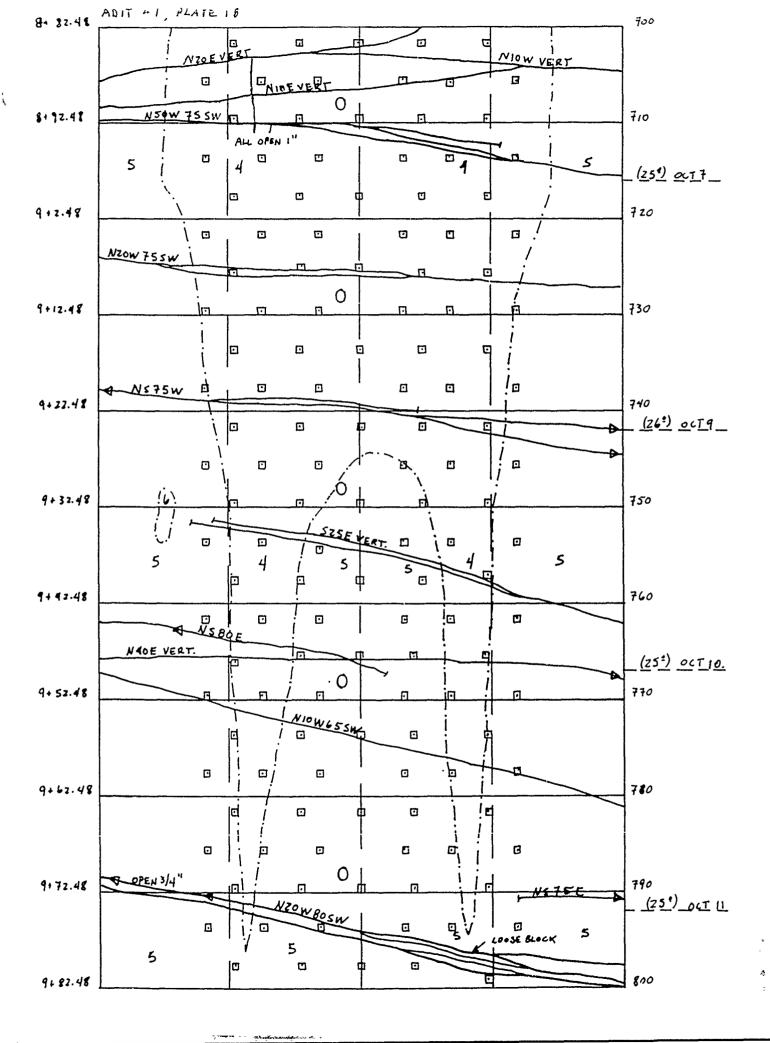


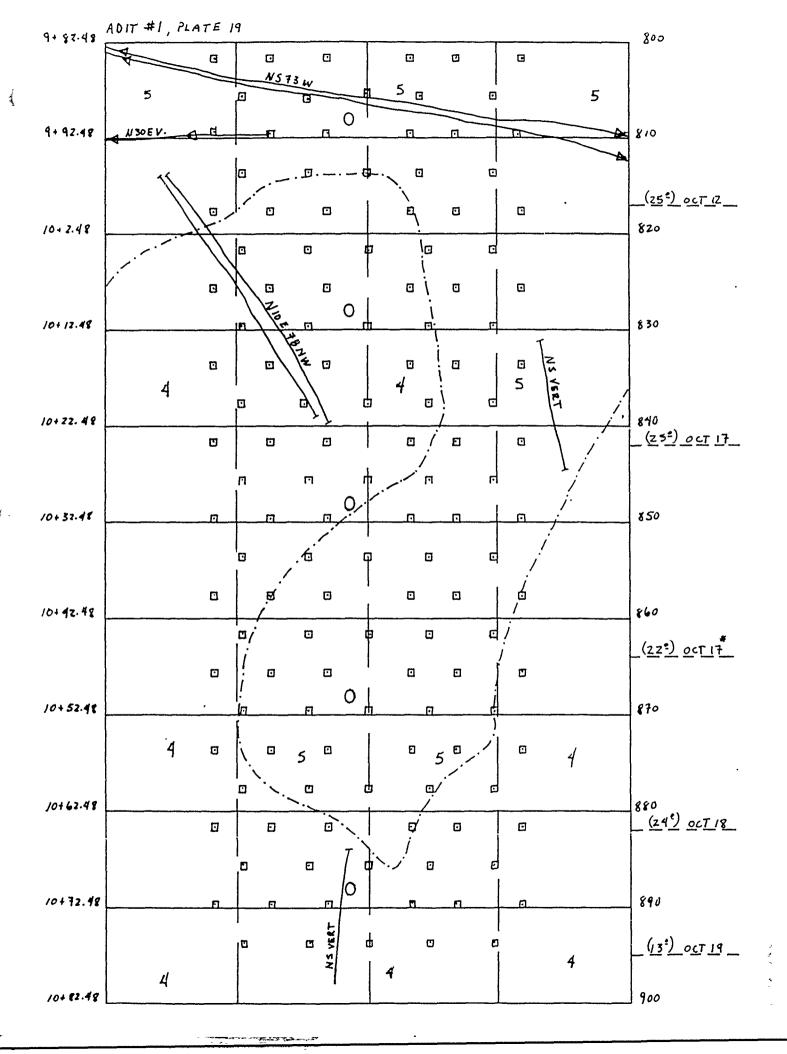
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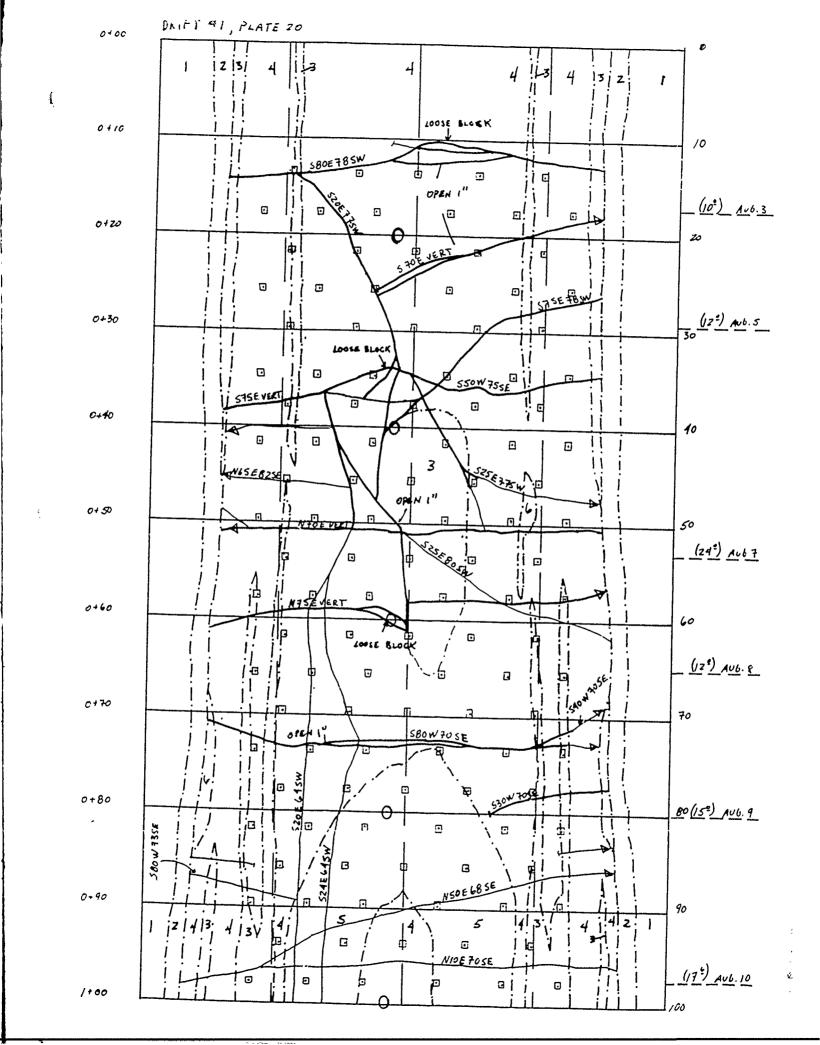


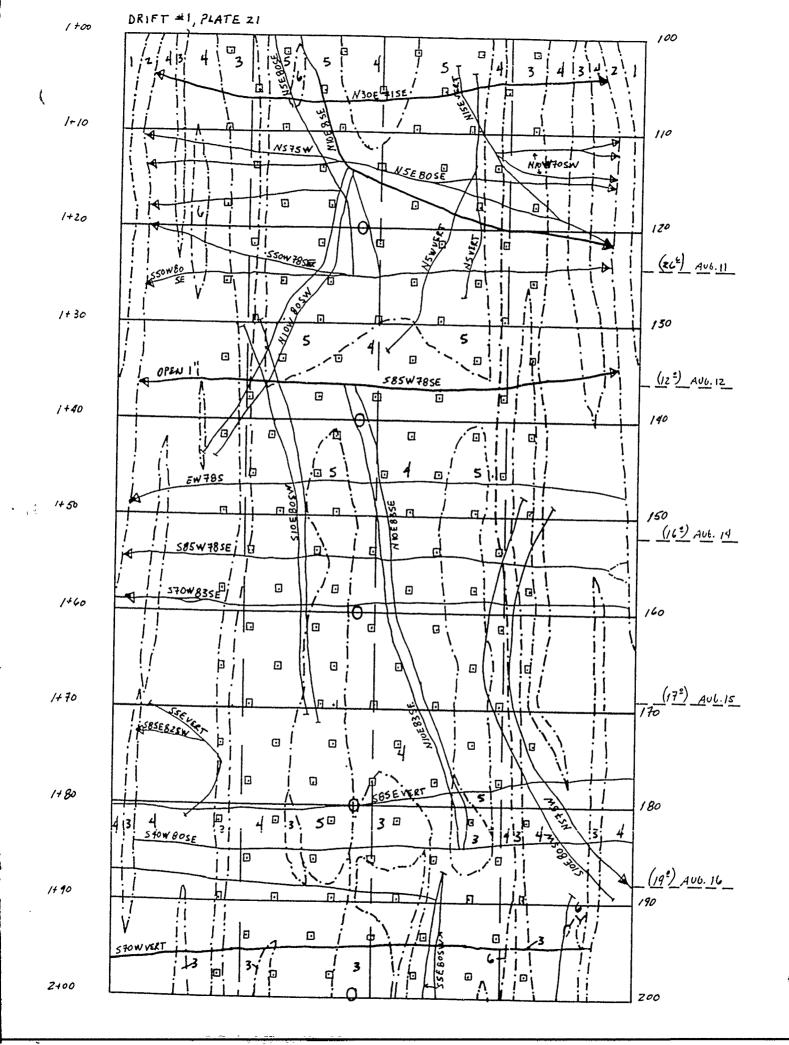


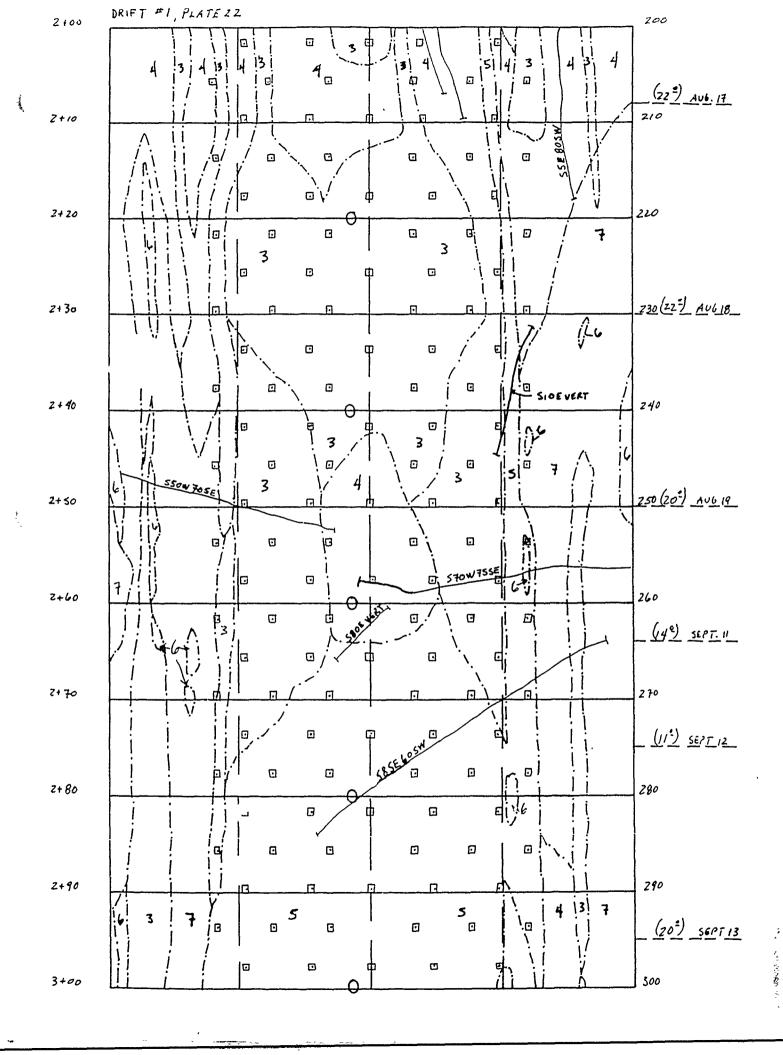


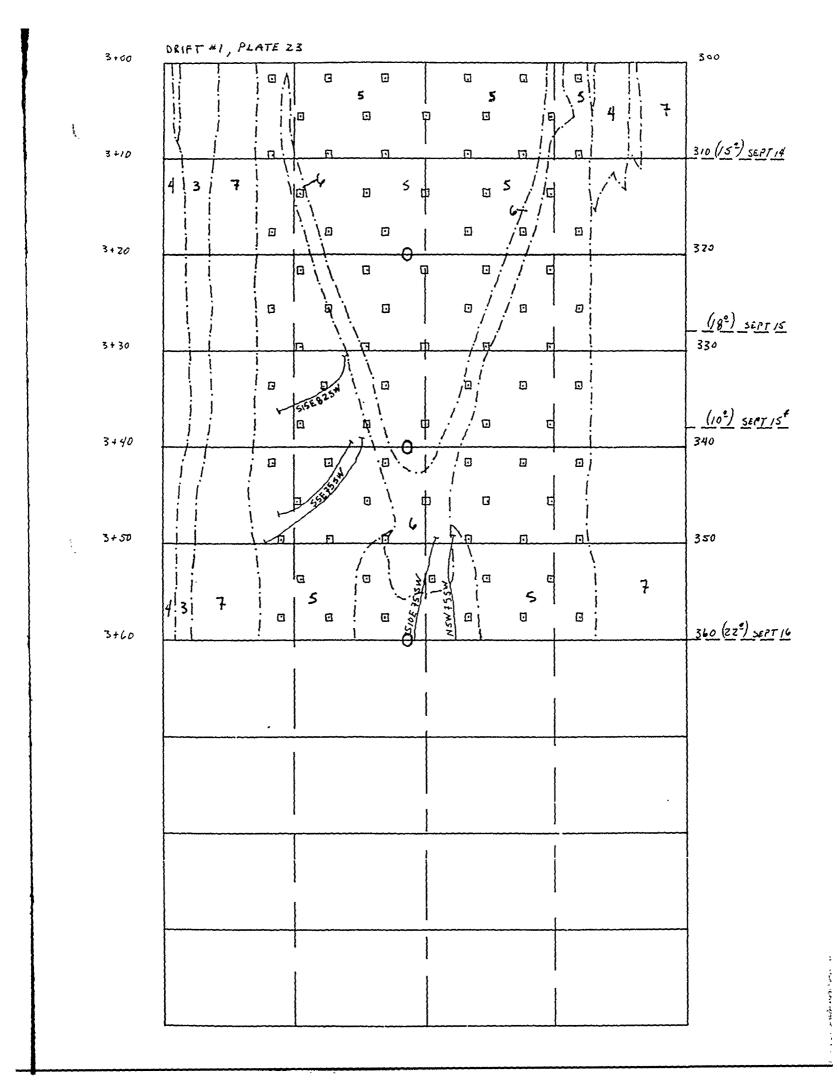












APPENDIX 8

<u>LITHOLOGIC DESCRIPTIONS</u>

## PORTAL NO. 1 - ROCK DESCRIPTIONS

1. Mudstone:

readily when exposed.

Dark red in color, unweathered, silty to clay texture, very fine grained, scattered

irregular pockets of bentonitic siltstone throughout, massive bedding, poorly cemented, blocky shape, tight and widely spaced joints with slickensides on joint surface, slakes

2. Mudstone:	Two to three inch green clay layer atop a 1 foot thick dark blue to black mudstone which was: soft, unweathered, had a silty texture, very fine grained, thinly bedded, poorly cemented, unfractured and contained abundant muscovite throughout.
2a. Clay:	Bentonitic clay concentrated near base of joints at sandstone/mudstone contact, light green in color, very fine grained, clay texture, massive, unfractured.
3. Sandstone.	White in color, slightly weathered, medium to coarse grained, sandy texture, fairly well cemented, massive bedding, tight and widely spaced joints, blocky shape, conglomeritic with depth. (Quartzarenite)
4. Sandstone:	Same as Item 3 above with FeO stains throughout, and closely spaced tight joints.
5. Sandstone:	Purple in color, soft, unweathered, sandy texture, fine grained, poorly cemented, massive bedding, unfractured, blocky shape. (Quartzarenite)
6. Mudstone.	Dark red in color, very soft to soft, unweathered, silty texture, very fine grained, poorly

7. Mudstone: Same as Item 6 above, with the exception of darker in color and more sand present.

cemented, massive bedding, unfractured, blocky shape.

- 8. Sandstone: White in color, soft to moderately hard, slightly weathered, sandy texture with medium size clasts, medium to coarse grained, thick bedding, tight and widely spaced joints, blocky shape, moderately cemented. (Quartzarenite)
- 9. Sandstone: Black in color, slightly weathered, sandy texture, fine grained, thinly bedded, tight and widely spaced joints, poorly cemented. (Quartzarenite)
- 10. Sandstone: Same as Item 9 with the exception of color (red) and the presence of mudstone.
- 11. Sandstone: Same as Item 9 with the exception of color (brown) and the presence of mudstone.
- 12. Siltstone. Purple in color, very soft, decomposed, fissile, shaly, very fine grained, tabular, very poorly cemented.

## PORTAL NO. 2 - ROCK DESCRIPTIONS

1. Mudstone:

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Dark reddish brown; very fine grained with scattered fine grains; moderately soft to soft; unweathered, laminated and slightly fissile; scattered irregular to well rounded nodules of soft bentonitic siltstone scattered throughout; muscovite is concentrated along lamination planes; close to very closely jointed; joints are smooth; tight and are slickensided and polished; in upper 1 foot, joints are coated with montmorillanite; poorly cemented; slakes readily when exposed.

2. Quartz Sandstone:

Primarily white; hard to very hard; fine to coarse grained; composed of fine to coarse, mostly medium to coarse, subangular quartz and quartzite grains with scattered subrounded gravel to 1 inch in a slightly caicareous and non-calcareous, siliceous cement; slightly weathered to unweathered; very thinly to thinly bedded and cross bedded; widely jointed; joints are tight, slightly rough to rough, and coated with minor FeO stains; moderately to well cemented, scattered thin beds of mostly coarse grained material.

3. Calcareous Conglomertic Sandstone:

Primarily white, hard to very hard; fine to very coarse grained, mostly coarse; composed of about 80% fine to coarse, mostly medium to coarse, subangular quartz and quartzite grains, and 20% subangular to subrounded quartz and quartzite gravel to 1.5 inches in a calcareous-siliceous cement; slightly weathered to unweathered; thin to medium bedded; widely jointed; joints are tight, slightly rough to rough, and coated with minor FeO stains and a trace of clay; moderately to well cemented; upper four feet is slightly to non-calcareous.

4. Quartz Sandstone:

White; fine to coarse grained with scattered, very coarse grains; moderately hard; composed of fine to coarse, with scattered very coarse to 1/2 inch, subrounded quartz and minor quartzite grains; unweathered; thin bedded and cross bedded; widely jointed; joints are slightly rough, tight; and have minor FeO stains; moderately to well cemented.

5. Sandy Mudstone:

Grayish red to very dark red; very fine to fine grained; moderately soft; composed of 75% clay and 25% fine, subrounded quartz grains in iron-silica cement; unweathered; laminated and fissile with abundant polished surfaces; close to very closely jointed; joints are smooth and tight; poorly cemented; slakes readily when exposed to air.

6. Quartz Sandstone:

White mottled with abundant FeO stains; fine to medium grained; soft to moderately soft; composed of subrounded quartz grains; moderately weathered; very thin bedded; moderately close jointed; joints are rough, open to 1 mm, with abundant FeO stains; moderately cemented.

7. Conglomeritic Quartz

Sandstone.

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Mottled very light gray and minor dark gray; very fine to very coarse grained, mostly coarse to very coarse; moderately soft to moderately hard; composed of fine to very coarse, mostly coarse to very coarse, subrounded to subangular quartz and minor quartzite grains to 3/8 inch; unweathered; thin bedded, very widely jointed; moderately cemented.

8. Sandstone.

Light gray; fine to coarse grained; mostly medium; moderately soft to moderately hard; composed primarily of subangular to subrounded quartzite grains with minor lithic, mafic, and quartz grains in siliceous cement; unweathered, thin bedded; very wide to widely jointed; joints are rough, tight and coated with minor CaCO3; moderately cemented.

9. Quartz Sandstone.

Mottled grayish red, white, pale red and light brownish gray; fine to coarse grained, mostly medium; composed of subrounded to subangular quartz grains and minor quartzite in an iron-silica cement; mottling is due to variation in FeO content of matrix as well as bleaching along bedding planes and in irregular masses; color is extremely variable; very thin bedded to laminated, cross bedded; moderately soft; slightly weathered; wide to very widely jointed; joints are tight and rough with minor FeO stains; very minor thin mudstone lamination and lenses scattered throughout, moderately to poorly cemented.

10. Sandstone.

Very thinly interbedded with laminated mudstone; sandstone is dark reddish brown; fine to coarse grained, mostly coarse; moderately soft, composed of subangular quartz and quartzite grains in iron-silica cement; mudstone is medium light gray; very fine grained; moderately soft; occurs as laminated irregular lenticular beds and masses with the sandstone; rock is slightly weathered, moderately close to widely jointed; joints are rough and tight; poorly to moderately cemented.

11. Quartz
Sandstone.

Mottled white and minor medium brownish gray; fine to medium grained, mostly medium with scattered coarse grains; moderately soft to moderately hard; composed primarily of subrounded to subangular quartz grains with scattered thin beds with abundant quartzite and some lithic and mafic grains, resulting in mottled appearance; quartzite is more abundant in bottom 1 foot; unweathered, thin to very thin bedded and cross bedded, wide to very widely jointed; joints are slightly rough to rough with FeO and minor MnO stains; moderately cemented.

12. Silty Sandstone.

Mottled grayish red and minor yellowish gray; very fine to fine grained, moderately soft; composed of 60% fine subrounded quartzite and quartz grains and 40% silt; slightly weathered; thin bedded; closely jointed, joints are rough, tight, and are coated with calcite and minor FeO stains; moderately to well cemented.

13. Siltstone.

Pinkish gray; very fine grained; moderately soft; medium bedded; siliceous; slightly weathered; very close to closely jointed; joints are slightly rough, tight to open to 2 mm, with abundant FeO stains, some clay, and scattered slickensides; moderately cemented; becomes fissile and slakes readily when exposed.

14. Quartz Sandstone:

Laminated to very thinly interbedded with sandy siltstone; 75% sandstone, 25% sandy siltstone; andstone is mottled white, grayish red purple and dark reddish brown; mottling is due of variations in the FeO content of cement in individual beds; fine to medium grained, mostly medium; moderately hard; composed of 70% subangular to subrounded quartz grains, 20% to 25% quartzite grains and 5% to 16% other lithic and black mafic grains; unweathered to slightly weathered; closely jointed, joints are rough, tight, with minor FeO stains; well cemented; sandy siltstone is medium dark gray, very fine to fine grained; moderately soft to moderately hard; composed of 75% silt and 25% fine quartz grains, unweathered, well cemented, thin beds of coarse gray sandstone and silty sandstone are scattered throughout; individual beds are laminated.

15. Quartz Sandstone.

Very light gray; fine to coarse grained, mostly coarse; moderately hard; composed of 90% subrounded to subangular, fine to coarse, mostly coarse, quartz grains and 10% irregular, thin dark gray mudstone lenses; unweathered; thin bedded and cross bedded; very widely jointed; well cemented.

## ADIT/DRIFT ROCK DESCRIPTIONS

1. Mudstone: Dark red in color, unweathered, silty to clay texture, very fine grained,

scattered irregular pockets of bentonitic siltstone throughout, massive bedding,

poorly cemented, blocky shape, tight and widely spaced joints with

slickensides on joint surface, slakes readily when exposed.

2. Mudstone: Two to three inch green clay layer atop a 1 foot thick dark blue to black

mudstone which was: soft, unweathered, had a silty texture, very fine

grained, thinly bedded, poorly cemented, unfractured and contained abundant

muscovite throughout.

3. Conglomeritic

Sandstone: White and blue in color, medium to coarse grained, clasts up to 2 inches in

diameter, hard, well cemented, unweathered, tight and closely to widely

spaced joints.

4. Sandstone: White in color, medium to coarse grained, moderately hard to hard, well

cemented, slightly weathered, tight to open and closely to widely spaced joints.

5. Sandstone: Blue in color, medium to fine grained, to moderately hard, moderately well

cemented, slightly weathered, tight to open and closely to widely space joints.

6. Mudstone/

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Clay: Dark blue to black in color, unweathered, clay texture, very fine grained,

poorly cemented, slakes readily when exposed.

7. Sandstone: Same as Item 4 with the exception of color (brown to black).

8. Mudstone: Dark blue to black in color, soft to very soft, tabular, very fine grained,

poorly cemented, unfractured.

9. Sandstone: White in color, medium to coarse grained, very hard, well cemented,

unweathered, cobbles up to 1 inch in diameter present.

10. Sandstone: Interbeded Item 4 and Item 5.

## APPENDIX 9

PHOTOGRAPHS C F CONSTRUCTION OF ADITS AND DRIFTS



PHOTO NO. 1 - VIEW OF NORTH ADIT NO. 1 (RIGHT) AND SOUTH ADIT NO. 2 (LEFT).

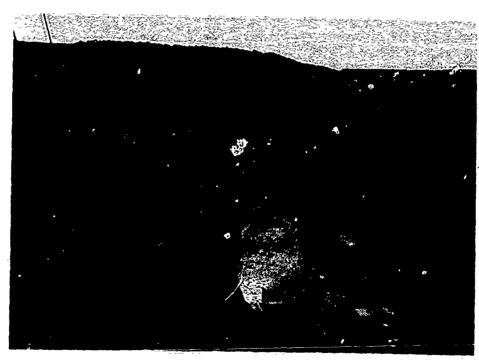


PHOTO NO. 2 - VIEW OF NORTH (COMPLETED) AND SOUTH (UNDER CONSTRUCTION) SETTLEMENT PONDS.

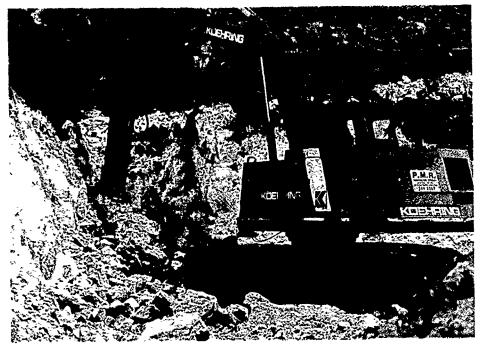


PHOTO NO. 3 - BACKHOE MOUNTED ROCK HAMMER EXCAVATING NORTH PORTAL FACE.

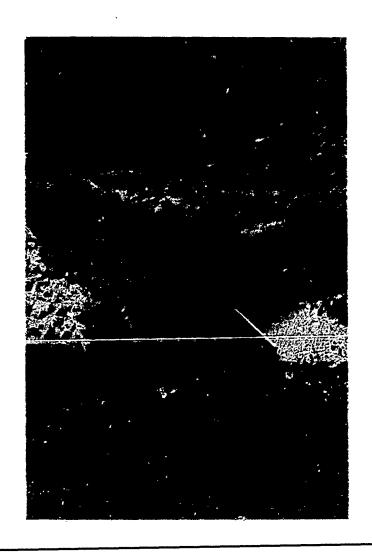


PHOTO NO. 4 INSTALLATION OF CHAIN
LINK FABRIC WITH ROCK
BOLTS TO PROTECT
PORTAL FACE. (NORTH
AREA)



PHOTO NO. 5 - EXCAVATION OF SOUTH PORTAL USING ALPINE MINER.

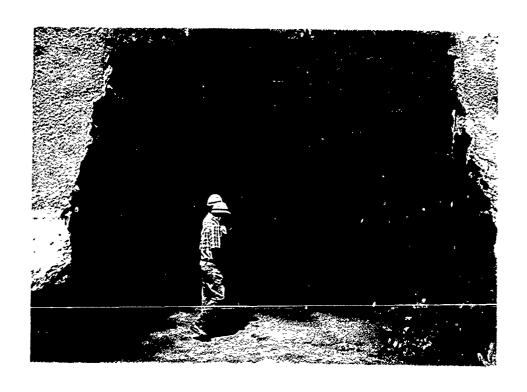


PHOTO NO. 6 - EXCAVATED NORTH PORTAL SHOWING ABO MUDSTONE, AGUA ZARCA SANDSTONE CONTACT.



PHOTO NO. 7 - WIER TO MEASURE ADIT DISCHARGE - SOUTH SIDE.

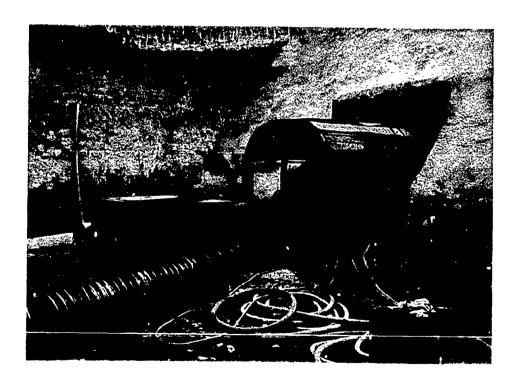


PHOTO NO. 8 - TEMPORARY PORTAL STRUCTURE FOR SOUTH PORTAL. (NOTE: SAME TYPE OF STRUCTURE WAS USED FOR NORTH PORTAL.)

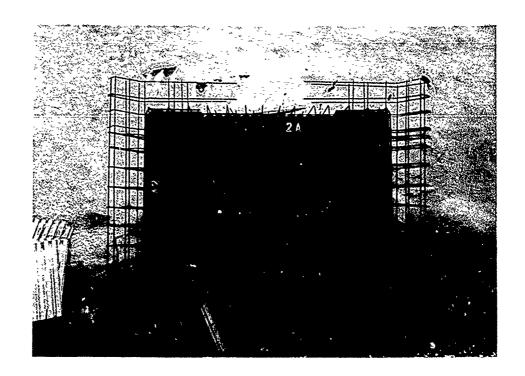


PHOTO NO. 9 - PERMANENT PORTAL FRAME. (TYPICAL BOTH PORTALS, SOUTH PORTAL SHOWN.)

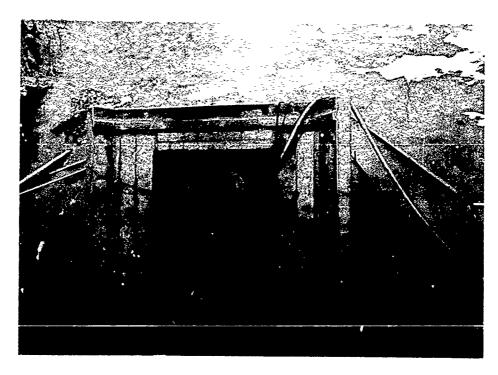


PHOTO NO. 10 - FINISHED CONCRETE PORTAL WITHOUT DOORS. (TYPICAL BOTH PORTALS, SOUTH PORTAL SHOWN)



PHOTO NO. 11 - ALPINE MINER ROADHEADER, ROC-MINER MODEL AEC-250, H SERIES  $\,$ 



PHOTO NO. 12 - ALPINE MINER APRON ASSEMBLY.

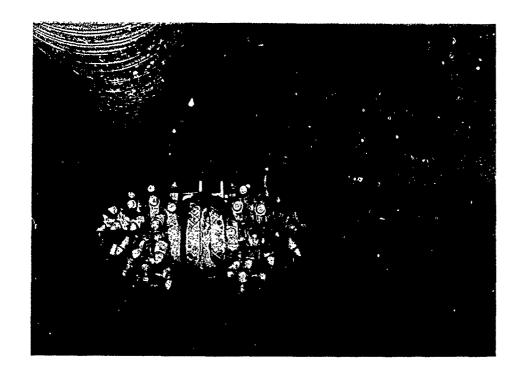


PHOTO NO. 13 - EXCAVATION HEAD ON ALPINE MINER ROADHEADER.



PHOTO NO. 14 - EXCAVATION HEAD ON DOSCO ROADHEADER.



PHOTO NO. 15 - DOSCO ROADHEADER, MODEL SL 120.

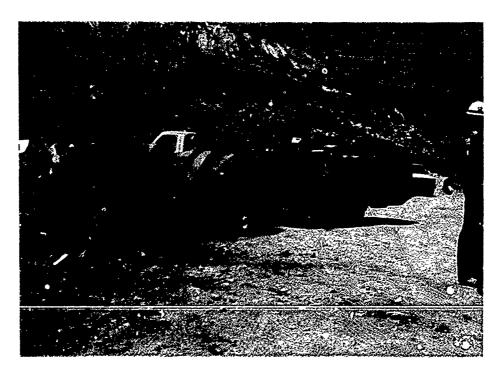


PHOTO NO. 16 - TYPICAL MUCKER USED IN ADIT CONSTRUCTION.

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PHOTO NO. 17 - VIEW OUTSIDE OF SOUTH PORTAL SHOWING LASER ALIGNMENT SYSTEM, SKIP LOADER AND LARGE LOADER USED IN ADIT CONSTRUCTION.

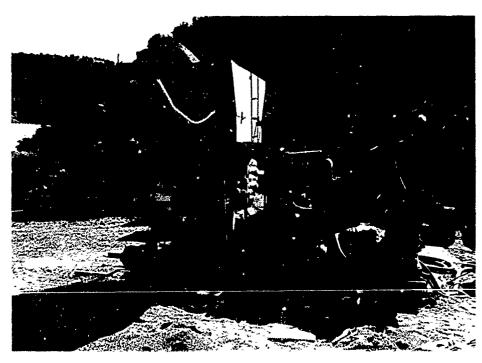


PHOTO NO. 18 - BATCH PLANT USED FOR SHOTCRETE PREPARATION.

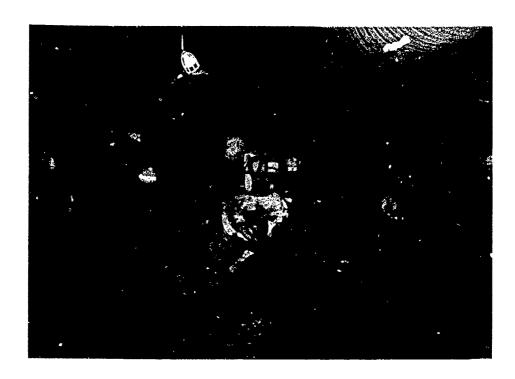


PHOTO NO. 19 - TYPICAL EXCAVATION USING ALPINE MINER ROADHEADER.

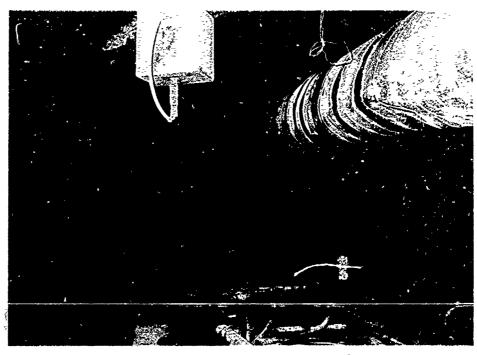


PHOTO NO. 20 - EXCAVATED TUNNEL DIMENSIONS SHOWING TYPICAL AMOUNT OF ADVANCE PER SHIFT. (NOTE: EXCELLENT STABILITY AND LACK OF OVERBREAK IN EXCAVATED SECTION.



PHOTO NO. 21 - TYPICAL FAULTING ENCOUNTERED, SOUTH ADIT, STATION 6+72

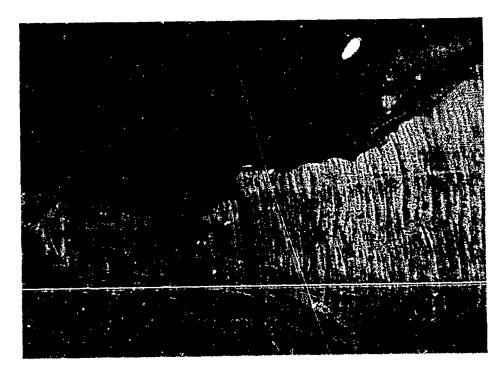


PHOTO NO. 22 - TYPICAL FAULTING ENCOUNTERED. SOUTH DRIFT, STATION 2+00.



PHOTO NO. 23 - CHECKING TUNNEL DIMENSIONS AND GRADE USING A MEASURING ROD AND LASER.



PHOTO NO. 24 - HYDRAULIC DRILLS USED TO ROCKBOLT.

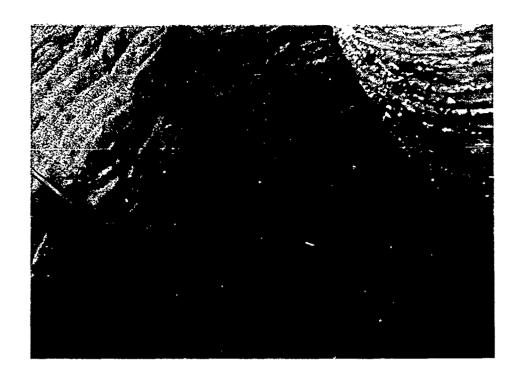


PHOTO NO. 25 - TYPICAL SUPPORT OF LOOSE ROCK WITH ROCKBOLTS.

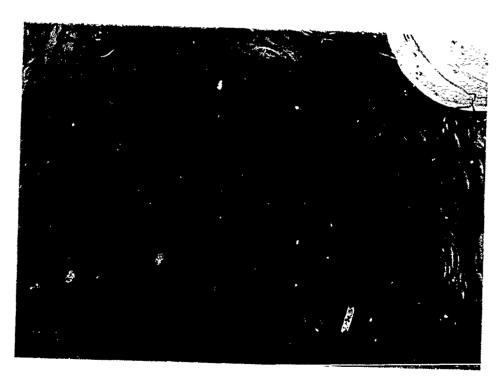


PHOTO NO. 26 - TYPICAL ROCKBOLT PATTERN. (NOTE: EXCELLENT TUNNEL EXCAVATION WITH NO OVERBREAK.)



PHOTO NO. 27 - APPLICATION OF SHOTCRETE TO TUNNEL WALLS.



PHOTO NO. 28 - VIEW OF SHOTCRETED TUNNEL, SOUTH ADIT STATION 5+00 (NOTE-SHOTCRETE DID NOT BOND BELOW SPRINGLINE.)



PHOTO NO. 29 - DRAINHOLE DRILLING IN SOUTH ADIT.

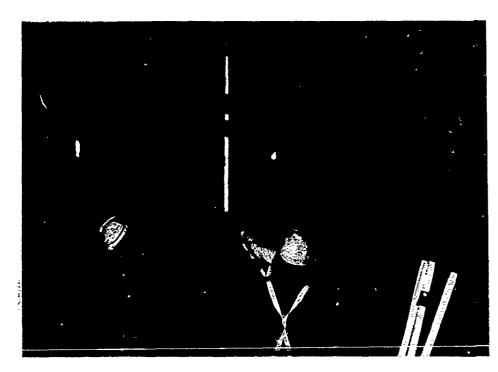


PHOTO NO. 30 - INSTALLATION OF PVC PIPE IN DRAINHOLE.



PHOTO NO. 31 - DIRECTIONAL SURVEYING TOOL BEING USED FOR DRAINHOLE SURVEY.



PHOTO NO. 32 - CORING TOOL USED FOR SHOTCRETE SAMPLING.

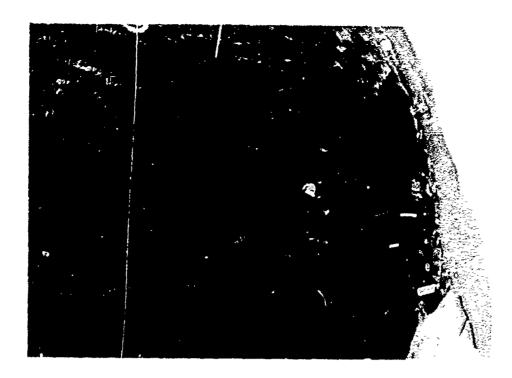


PHOTO NO. 33 - TUNNEL PRIOR TO SHOTCRETE APPLICATION. (TYPICAL.)

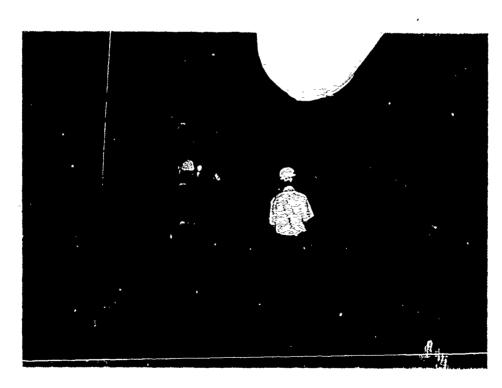


PHOTO NO. 34 - TUNNEL AFTER SHOTCRETE APPLICATION. (TYPICAL.)

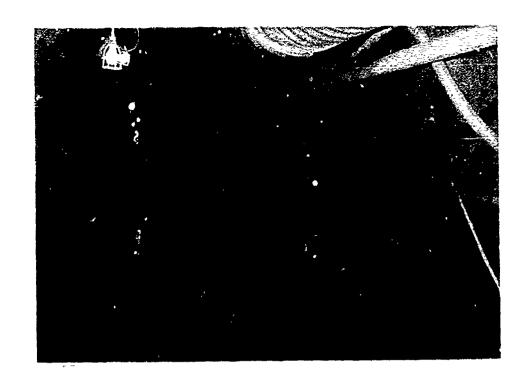


PHOTO NO. 35 - TUNNEL BIFURCATION - NORTH ADIT - NORTH DRIFT.



PHOTO NO. 36 - TUNNEL BIFURCATION - SOUTH ADIT - SOUTH DRIFT.



PHOTO NO. 37 - PROBLEM AREA - SHOTCRETE SLUFFING BELOW SPRINGLINE EXPOSING MUDSTONE. SOUTH ADIT, STATION 0+86.

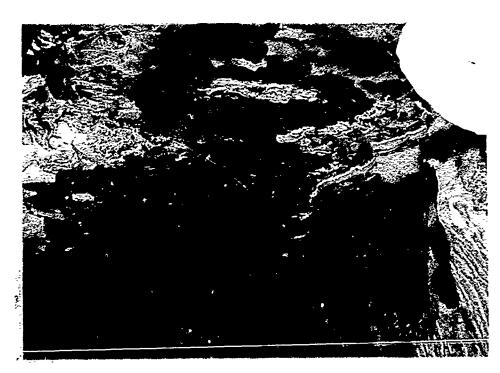


PHOTO NO. 38 - ATYPICAL CONDITION - MUDSTONE SECTION ENCOUNTERED ALONG CROWN IN NORTH ADIT BETWEEN STATION S 7+08 AND 7+64.

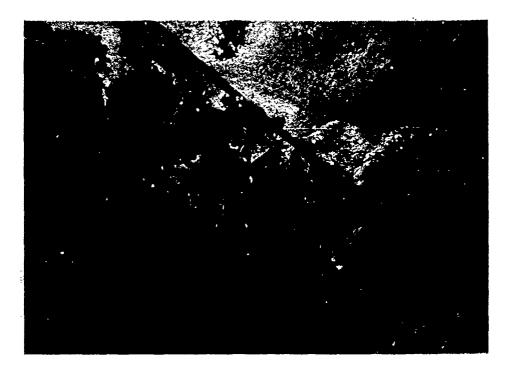


PHOTO NO. 39 - SEEPAGE AREA ON TUNNEL CROWN (STATION 2+90, NORTH ADIT). NOTE: THIS IS ONE OF A VERY FEW AREAS WHERE SEEPAGE WAS ENCOUNTERED ON CROWN.

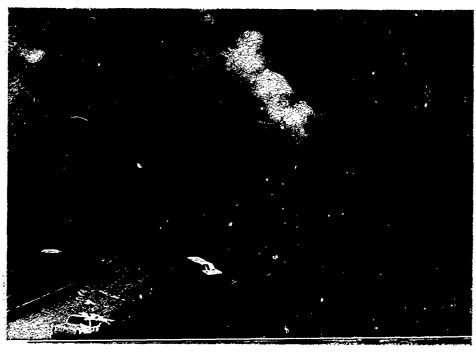


PHOTO NO. 40 - ADIT CONSTRUCTION SOUTH ADIT.



PHOTO NO. 41 - COMPLETED PERMANENT PORTAL STRUCTURE. (TYPICAL BOTH PORTALS, SOUTH SHOWN.)

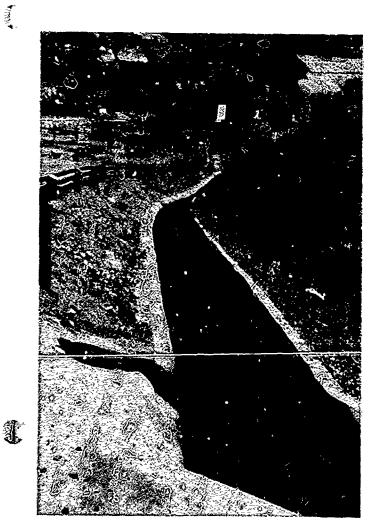


PHOTO NO. 42 - CONCRETE WATERWAY CARRYING SOUTH ADIT DISCHARGE TO RIO CHAMA.

APPENDIX 10

PERTINENT DESIGN PLANS



LEGING

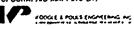
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LEGENO AB-C7 COME HOLES DALLED IN 1957 EXISTING PETCHETERS

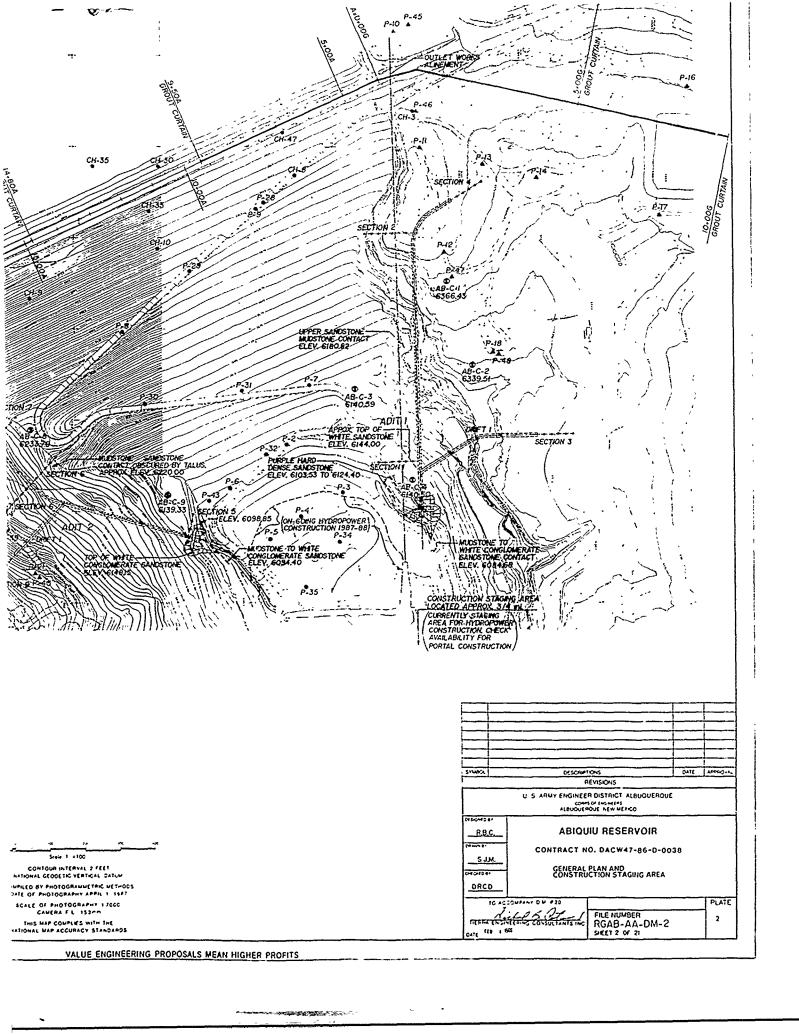
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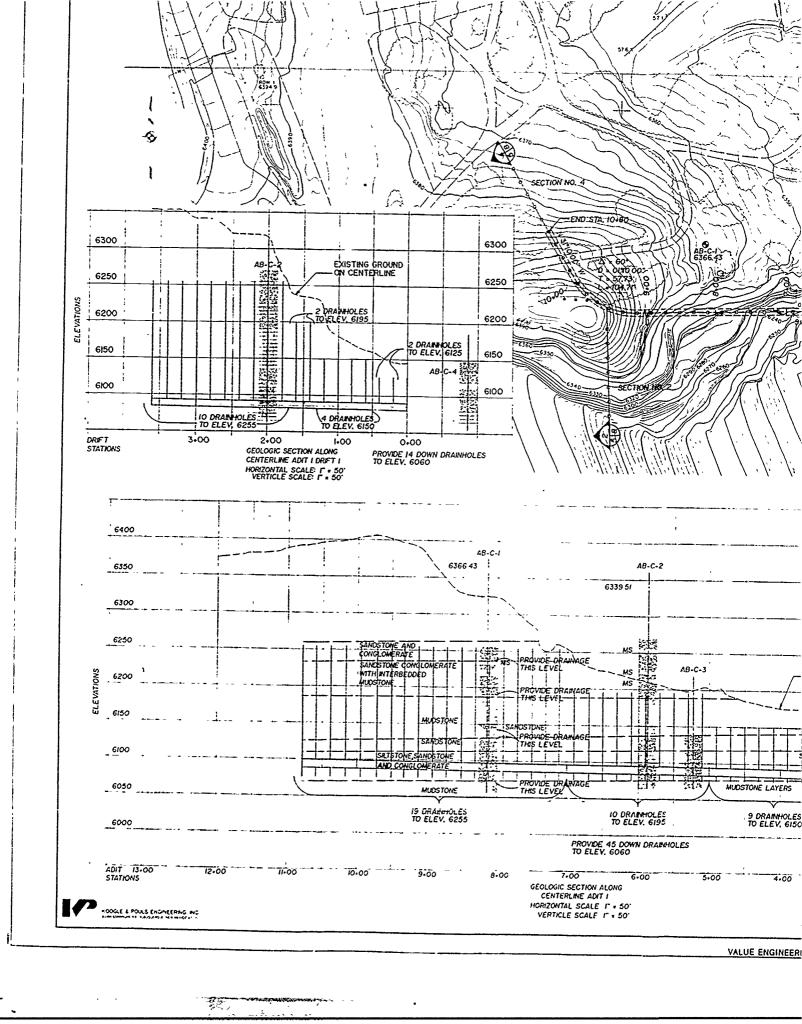
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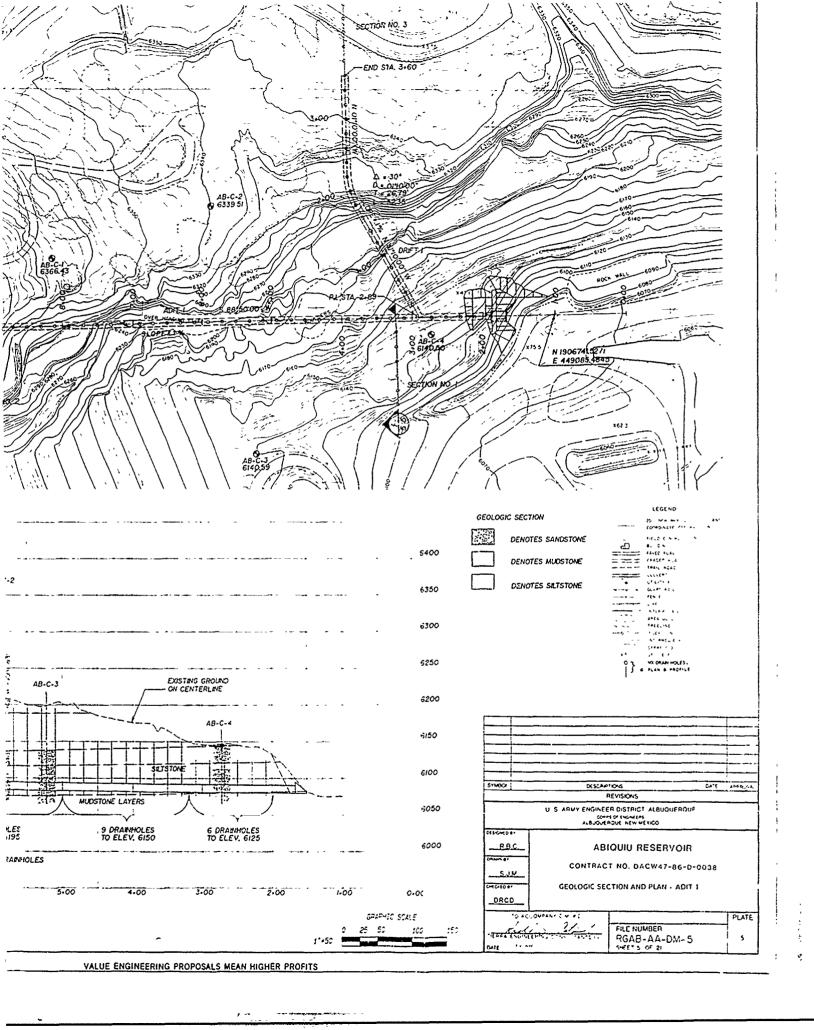
TOPOGRAPHIC MAPPING BY:

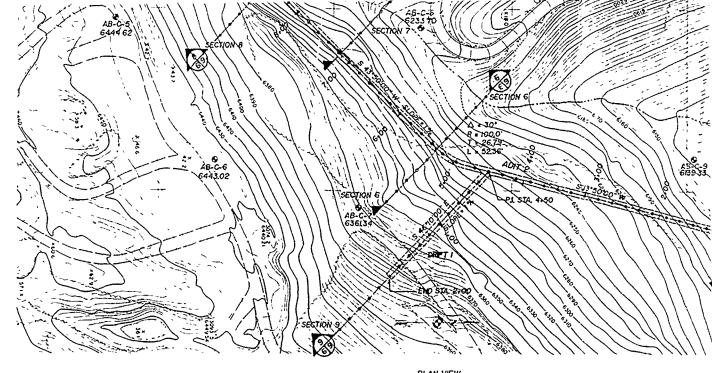


VALUE EN

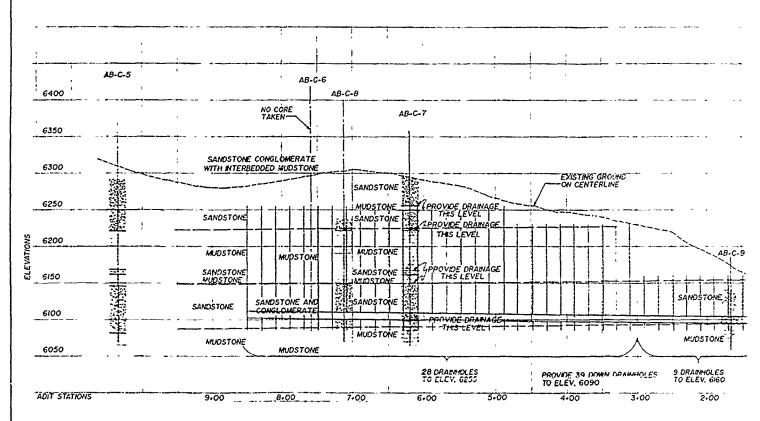








PLAN VIEW ADIT 2 SCALE: I' = 50'

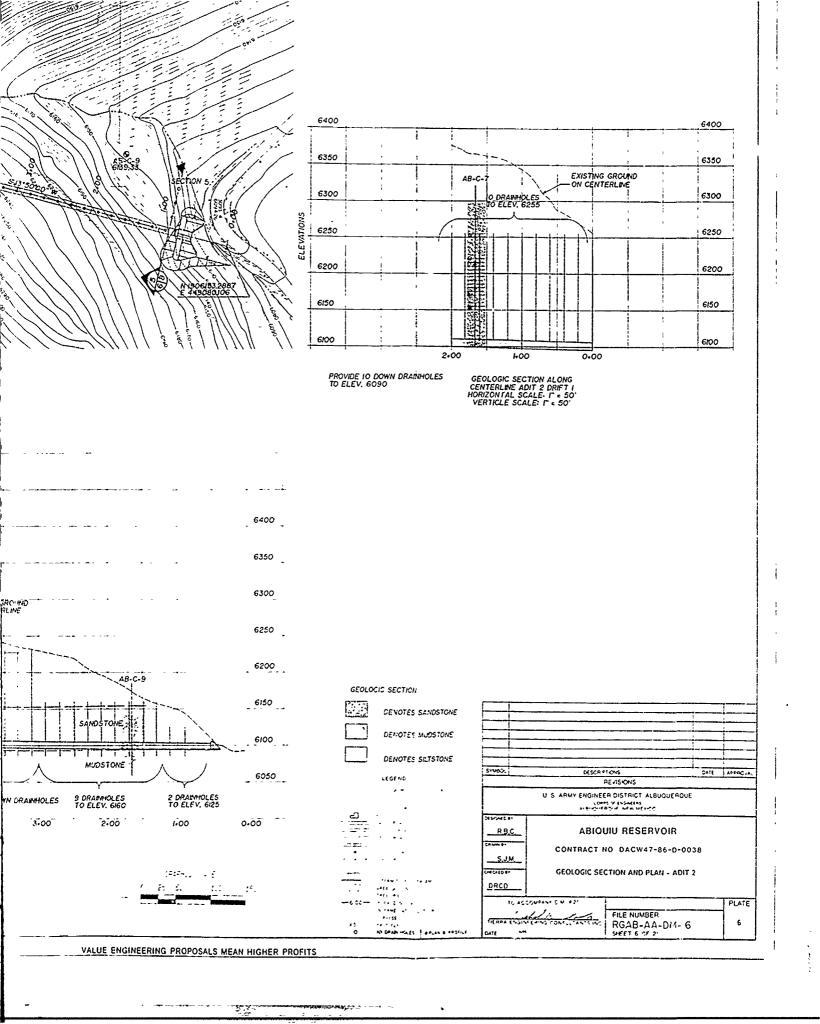


GEOLOGIC SECTION ALONG
CENTERLINE ADIT 2
HORIZONTAL SCALE 1" = 50
VERTICLE SCALE 1" = 50

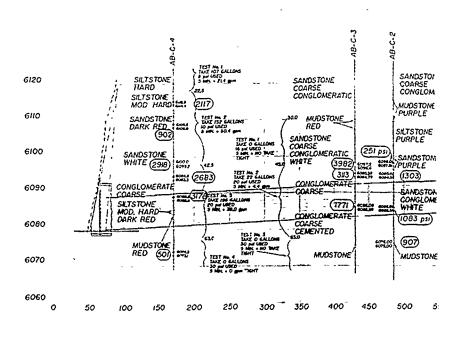


GLE & POULS ENGAGERING INC

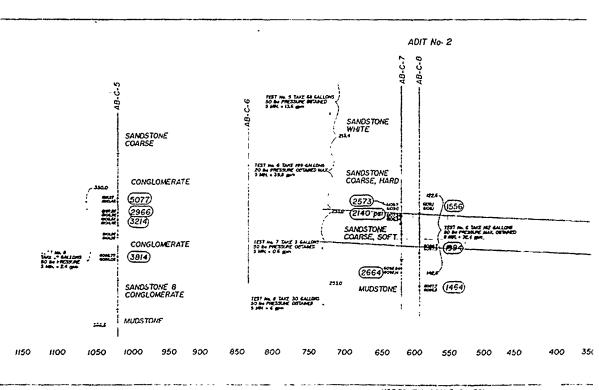
VALUE ENGINEER







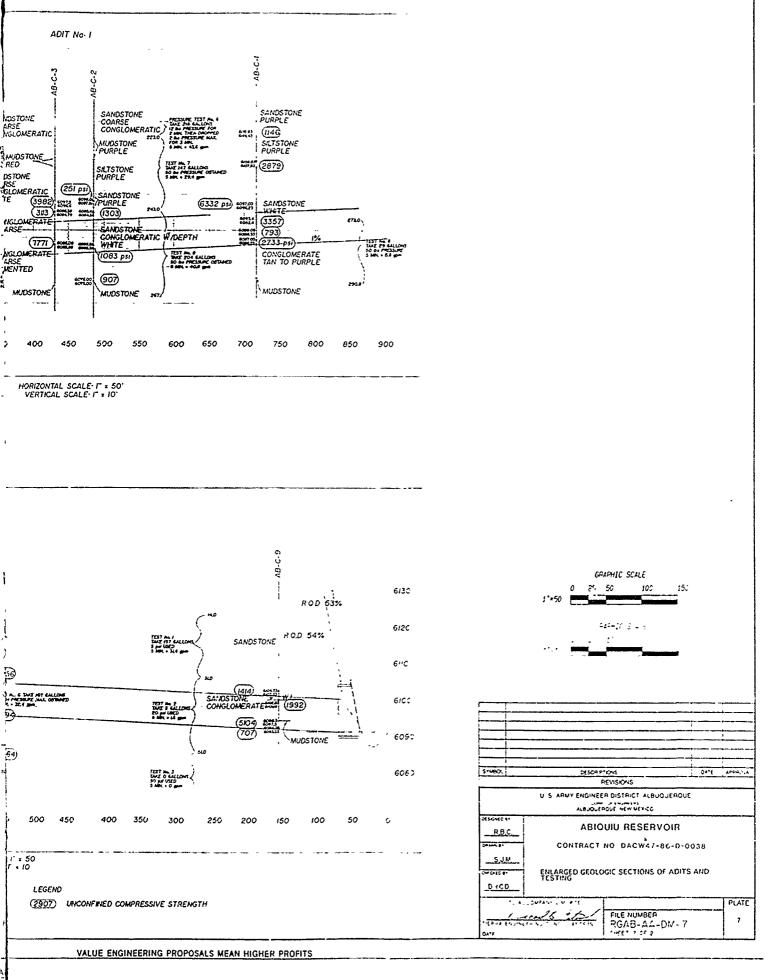
HORIZONTAL SCALE: 1" = 50' VERTICAL SCALE: 1" = 10'

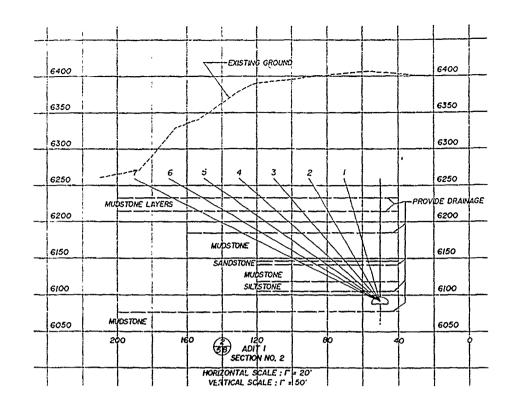


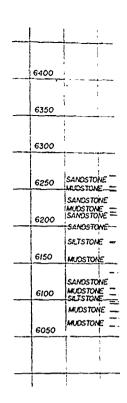
HORIZONTAL SCALE: F : 50' VERTICAL SCALE: F : 10'

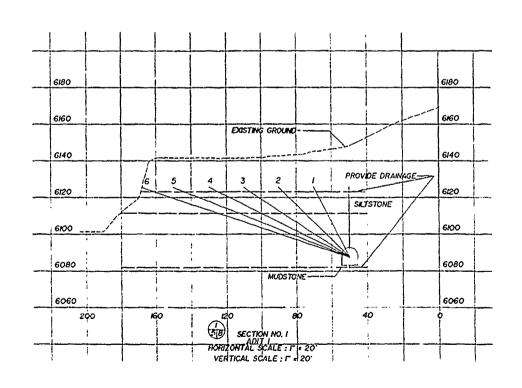
LEGEND

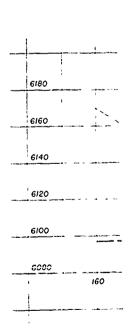
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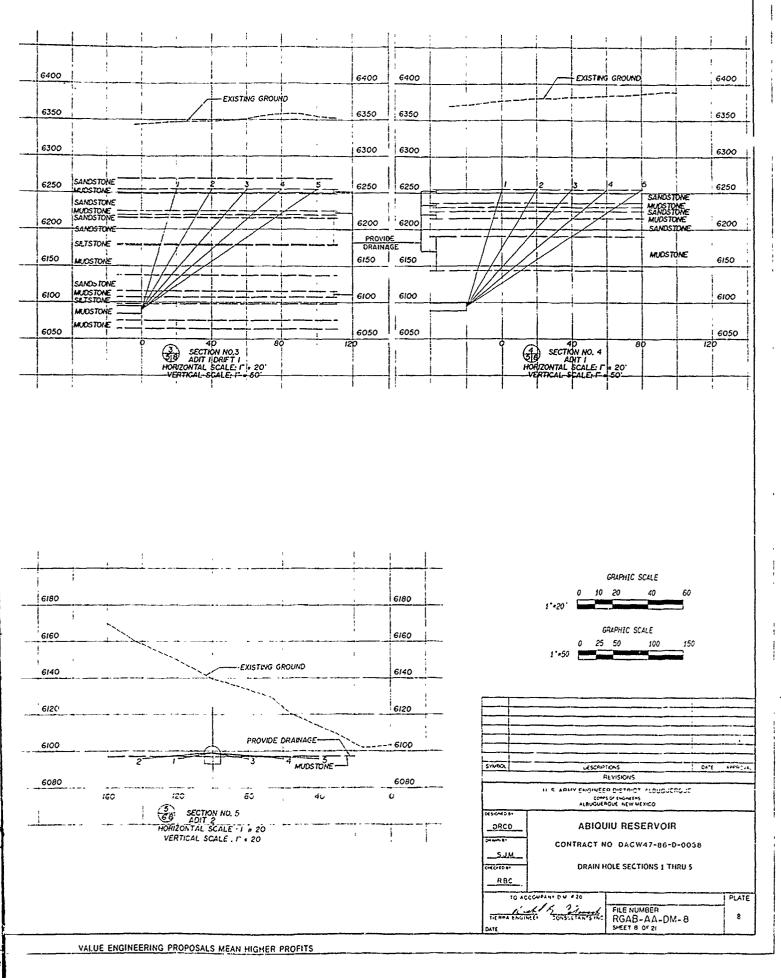












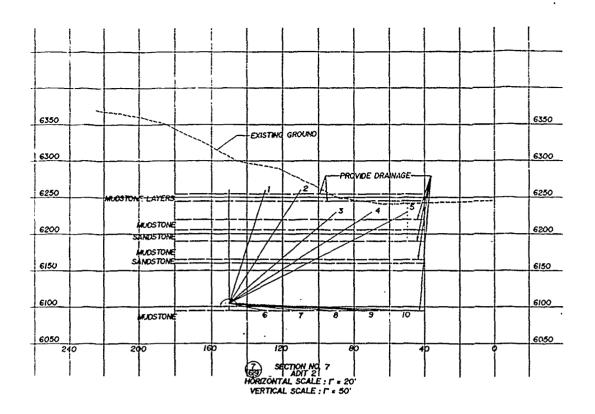
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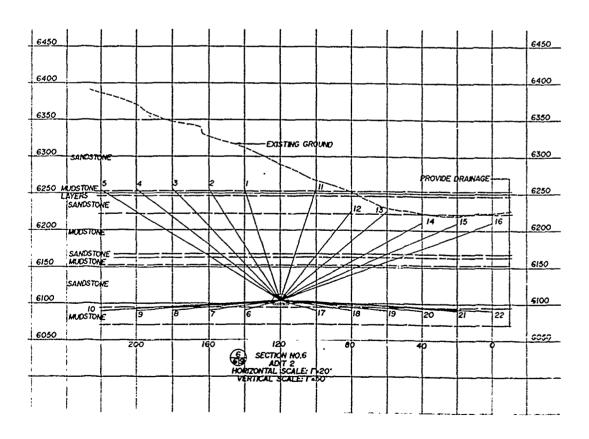
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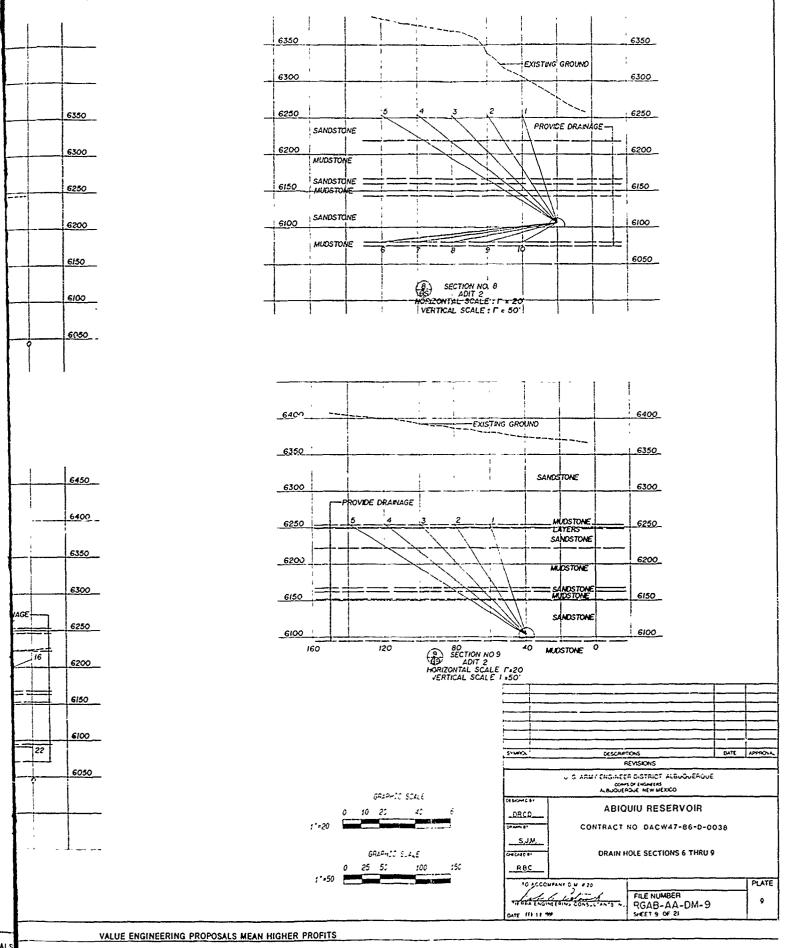
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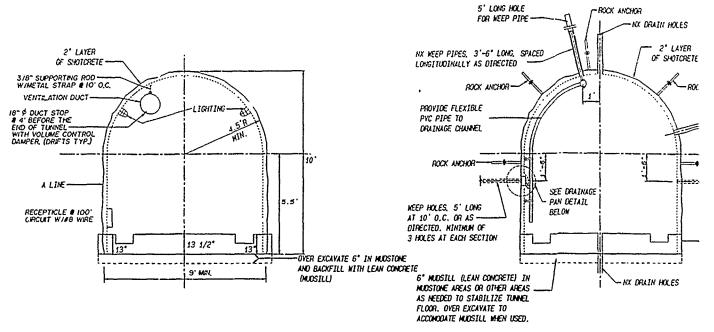
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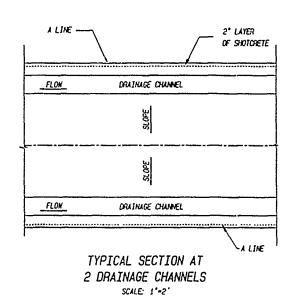




TYPICAL TUNNEL SECTION
WITH UTILITIES
SCALE: 1\*=2\*

REINFORCEMENT SCALE: 1°=2'

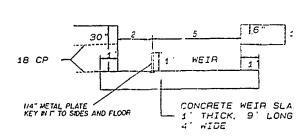
UNSUPPORTED OR ROCK



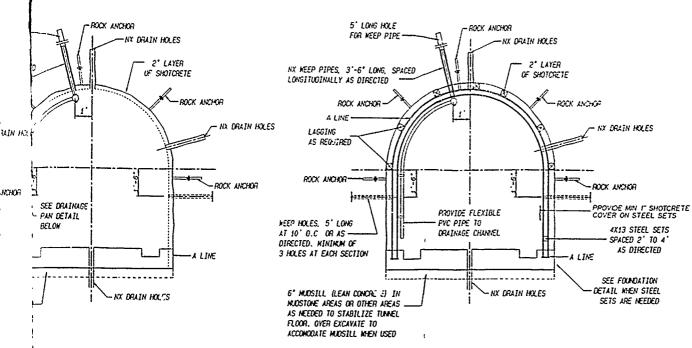
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SEPACE FLOWS PANS
SEPACE FLOWS PAID COM
MEEP HOLES OR DIAGE
LARGE SEPAGE FL
DRAINAGE CHAINGEL
CAN ALSO BE USED TO
LARGE FLOWS PRIOR TO SEE

PROVIDE 1 1/2" PIGIAIL
DRAINAGE PIPE AS MEEDED

DRAINAGE PAN DETAIL



CONCRETE WEIR DETAIL



UNSUPPORTED OR ROCK REINFORCEMENT SCALE: 1'=2'

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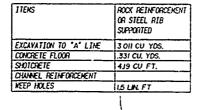
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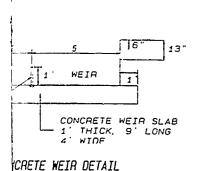
SUPPORTED SCALE. 1 . 2'

STEEL RIB

## ESTINATED QUANTITIES (PER LIN FT. OF TUNNEL)



- SHOTCRETE USE PANS TO CAPRY AWAY EXCESS SEEPAGE FLOWS. PANS MAY BE ORIENTED HORIZONTALLY AND CONNECT SEVERAL KEEP HOLES OR DIAGONALLY TO CARRY LARGE SEEPAGE FLOWS TO THE DRAINAGE CHANNEL THIS TECHNIQUE CAN ALSO BE USED TO DRY AREAS WITH ITH CATION LARGE FLOKS PRIOR TO SHOTCRETE APPLICATION. FD GE PAN DETAIL TO SCALE



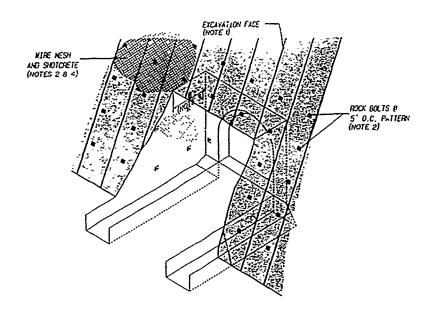
SCALE 1'-2'

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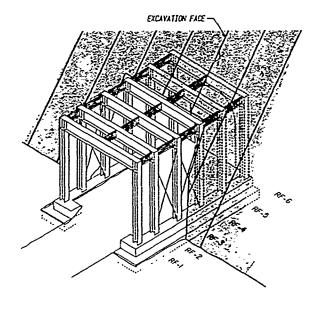
NOTES FOR PLAN AND PROFILE. SEE PLATES 5 & 6 FOR DETAILS OF TYPICAL SIEEL RIB SUPPORTS AND ROCK REINFORCEMENT, SEE PLATES 12 6 13 FOR MISCELLANEOUS TUNNEL REQUIREMENTS, SEE THIS PLATE DRILL HOLES FOR WEEP HOLES AND INSTALL WEEP PIPES AFTER THE SHOTCHETE LINING IS IN PLACE

> STARCE CATE APPROVA DESCRIPTIONS REVISIONS U. S. ARMY ENGINEER DISTRICT, ALBUQUERQUE ALBUQUERQUE HEW MEXICO **ABIQUIU RESERVOIR** R.B.C. CONTRACT NO. DACW47-86-D-0038 SJM TYPICAL ADIT SECTIONS DRCD TO ACCOMPANY C W #20 PLATE FILE NUMBER 11 RGAB-AA-DM-II

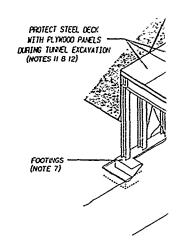
VALUE ENGINEERING PROPOSALS MEAN HIGHER PROFITS



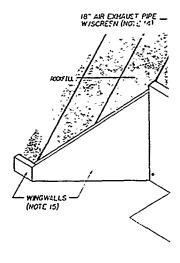
PARTIAL EXCAVATION SKETCH



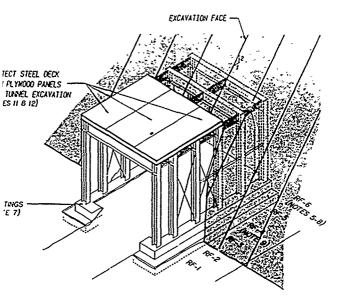
FRAMING ISOMETRIC SKETCH



DURING . ISO

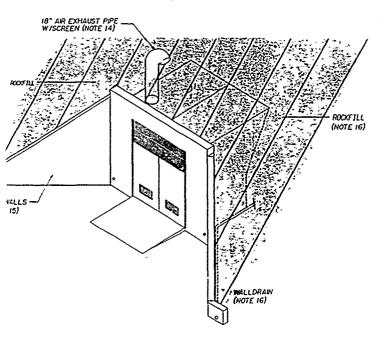


FINISH



## DURING ADIT CONSTRUCTION ISOMETRIC SKETCH

NO SCALE

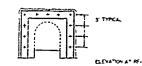


FINISH CONCRETE SKETCH NO SCALE

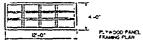
## ADIOLIU - TUNNIL PORTAL CONCEPT

The portal construction sequence is as follows

- Clean off face after prespiriting operation and develope a fevel work surface bench
- Install rock bolts and mesh above and around portal
- Apply 2" layer of shotcrete to rock faces
- Install rock bolts at 3° O'O'C for RF 6



- Install RF6 connecting RF-6 to PR. Noring took bolts and blocking between RF6 and shotcrete faces
- Install RF-1 thru RF-5 with 2 x 2 x 1 4 Z cross bridging between r gid frame girders and 1/2° f cross beating between rigid frames 2, and 3, and 4
- Shotcrete walls and ceiling and rigid frames RF-4-9 and 6 at portal except for wall area 9 ft wide by 10 ft high where tunnel starts
- Install steel deck on rigid framesRF-1 2 3 and 4 for future concrete slib

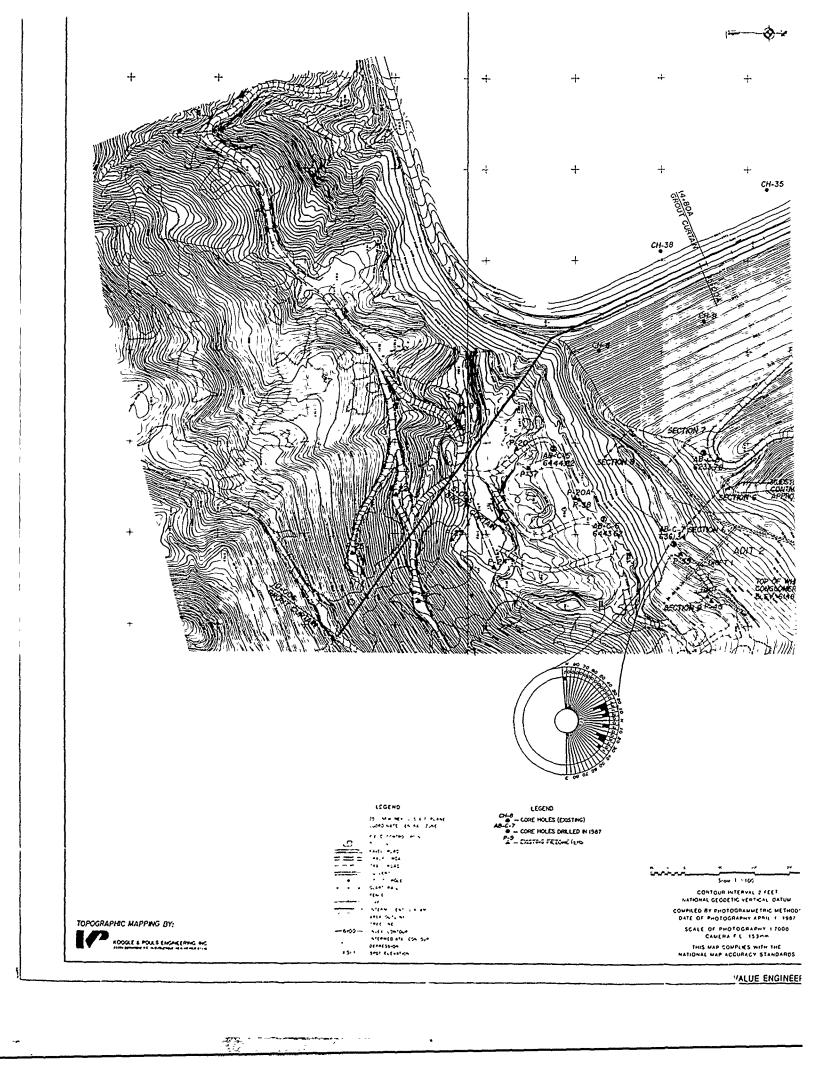


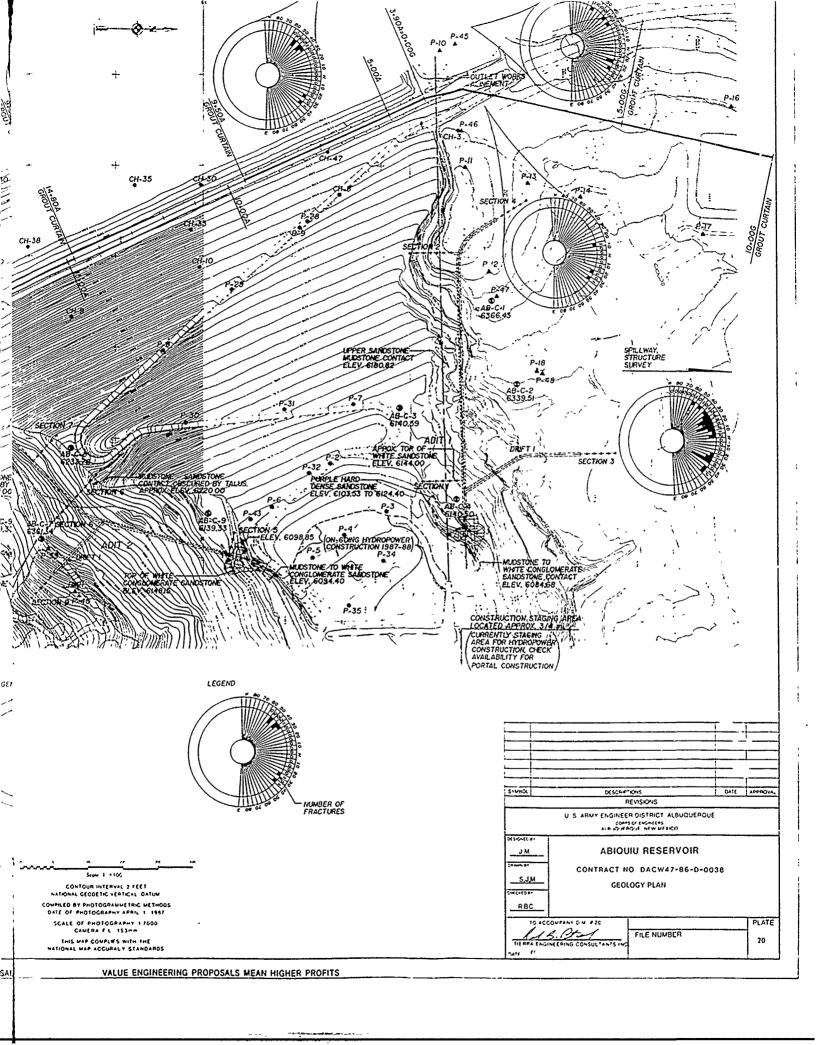
Anchor panels to deck as required to remain in place during constructor (purpose of temporary panels is to prote, a steel deck from impact of stones rolling off bill)

- Tunnel construction to commence that
- After tunnel is complete remove temporary plywood panels, form and place concrete floor and pit, walls and noof, well an essent
- Install wall drains and file around sinustone
- Install louvers and doors lighting and ventilation in portal

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10	ACCOMPANY DV #26		PLATE
	FILE NUMBER RGAB-AA-DM-	14	14

VALUE ENGINEERING PROPOSALS MEAN HIGHER PROFITS





APPENDIX 11

DRILLING LOGS

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8. DEPTH OR						INSPECT							
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1160 S DRIFT Hole No DIVISION INSTALLATION DRILLING LOG <u>5.w.</u>ù MLBURLEKRUF DISTRICT I. PROJECT 10. SIZE AND TYPE OF BIT NX
11. DAYUM FOR ELEVATION SHOWN (TUM or MSL) ABIGUIU DAM
2 LOCATION (Coordinates or Station) 6108.59 SOUTH DRIFT (HZ STHNUICK ALBUQUE R QUE 4. HOLE NO. (As shown on drawing title and lite number) DISTRICT UNDISTURBED 13. TOTAL NO. OF OVER- DISTURBED BURDEN SAMPLES TAKEN 1160 14. TOTAL NUMBER CORE BOXES S NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL 20 OCT 1989 19 007 1989 DERTICAL DINCLINED 17. ELEVATION TOP OF HOLE 6255 THICKNESS OF OVERBURDEN 16. TOTAL CORE RECOVERY FOR BORING 1472 DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR . TOTAL DEPTH OF HOLE 147 REMARKS (Drilling time, water loss, depth of weathring, etc., if significant) 9 % CORE RECOV-ERY BOX OR SAMPLE NO. f CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGENO 6108.59 SANDSTONE: WHITE TO RED, FINE TO COARSE GRAINED. 6149 MUDSTONE: DARK RED, SOFT, GREEN SILTSTENE PRESENT

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SHEET I HOIT Hole No. INSTALLATION DRILLING LOG 5.W. J. OF 3 SHEETS ALBUNVEKRUE DISTRICT 10. SIZE AND TYPE OF BIT // X
11. DAYUM FOR ELEVATION SHOWN (TUM or MSL) ABIQUIU DAM LOCATION (Coordinates or Station) 1,106 16 MANUFACTURER'S DESIGNATION OF DRILL SOUTH ADIT (#2) STANK ICK

13. TOTAL NO. OF OVER- DISTURBED BURDEN SAMPLES TAKEN ALBUQUERQUE
HOLE NO. (As shown on drawing lille
and lile number) DISTRICT UNDISTURBED 3150 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL DRILLING STARTED COMPLETED 9 NOV. 1989 10 NOT, 1989 ENTICAL MINCLINED \_ DEG. FROM VERT 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 1271 275 2 4 3 IS. TOTAL CORE RECOVERY FOR BORING 1192 6. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 119 = 9. TOTAL DEPTH OF HOLE CLASSIFICATION OF MATERIALS (Description) % CORE BOX OR SAMPLE NO. REMARKS (Drilling time, water loss, depth of weathering, etc., if eignificant) g ELEVATION DEPTH LEGEND 6106.16 SANDSTONE! WHITE AND RED, FINE TO MEDIUM GRAINED 4149 MUD STONE . RED TO BROWN , 1/5. SOFT. UREEN SILT STONE PRESENT HOLE HO PROJECT ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

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DRILLING LOG 5.0.0 10. SIZE AND TYPE OF BIT A/X
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) I. PROJECT ABIOUIU BAM
2. LOCATION (Coordinates or Station) 6107-0 SOUTH ADIT (42) ALB. DIST. 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 4130 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15, ELEVATION GROUND WATER CONTINENTIL DRILL ING 16. DATE HOLE SVERTICAL SINGLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING DEPTH DRILLED INTO ROCK 1182 19. SIGNATURE OF INSPECTOR 118= . TOTAL DEPTH OF HOLE % CORE RECOV-ERY BOX OR SAMPLE NO. CLASSIFICATION OF MATERIALS DEPTH LEGEND ELEVATION 61070 SANDSTONE: RED AND WHITE FINE TO MEDUM GRITINED 4149 MUDSTONE : DARK BROWN TO RED, SANDY IN AREAS. 45 HOLE HO. FROJECT ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE. ABBUIL DATT

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KILLING	LOG	Cont S	heet) ELEVATION TOP	6	225				Hole No. 4+30 3 A17	-
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Hole No. 5110 S ADIT DIVISION INSTALLATION SHEET ( DRILLING LOG 5.w.D ALBUKLEREWLE 10. SIZE AND TYPE OF BIT
11. DAYUM FOR ELEVATION SHOWN (TBM or MSL) ABINULU DAMA
LOCATION (Coordinates of Station) G/CF U
MANUFACTURER'S DESIGNATION OF DRILL SOUTH ADIT (HZ) CP65 ALB. DIST.

HOLE NO. (As shown on drawing title and file number) UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 5710 14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER CONTINEN THE 16. DATE HOLE 1989 1 DEC SVERTICAL SINCLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 6255 . THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING . DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR TOTAL DEPTH OF HOLE CORE BOX OR SAMPLE NO. REMARKS
(Drilling time, water lose, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 61000 0.0 -SANDSTONE ! WHITE AND RED, FINE TO MEDIUM GRAINED MUDSTONE. RED TO BROWN, SOFT, GREEN SILTSTONE PRESENT

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Holo No. 5170 411 5 Apir DIVISION HSTALLATION SHEET / DRILLING LOG OF 3 """ SWD ALBUQUER QUE 10. SIZE AND TYPE OF BIT // X
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) I. PROJECT ABIQUIU DAM

2. LOCATION (Coordinates or Station)

SOUTH ADIT (HZ)

3. ORILLING AGENCY 6/08. 1 CP65 ALB. DIST.
HOLE NO. (As shown on drawing title and file number) UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 5120 H11 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER CONTINENTE DRILLING 18. ELEVATION GROUND WATER COMPLETED 16. DATE HOLE TVERTICAL THELINED 17. ELEVATION TOP OF HOLE 6255 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 1492 DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 1492 TOTAL DEPTH OF HOLE CORE BOX OR SAMPLE NO. REMARKS (Drilling time, water lose, depth of weathering, etc., if eignificant) 9 CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 6108: SANDSTONE WHITE TO RED, FINE TO MEDIUM CHINED MOTE . .. A TICHS WERP-FILL . A ANGLE 4151 MUDSTONE! RED TO DARK BROWN SOFT, SANDY IN AREAS 45

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT ASJUVIU DATI

HOLE HO

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE 6255 Hole No. 5420 #11 5 A AT SHEET & % CORE BOX OR RECOV. SAMPLE NO. OF 3 SHEETS ALB. ABIQUIU DAM REMARKS
(Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 50 MUDSTONE AS A130UE ENG FORM 1836-A (UR 1110-1-1801) HOLE HO 517 41/ 4/2 PROJECT GPO 1960 OF - 628 - 603 ABIDOLU DALLI

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DRILLING	LOG	(Cont S	heet) ELEVATION TOP OF HO	1. 6255			Hole No. @2-	+11 < 40.7
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ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF		RECOV.	BOX OR SAMPLE NO.	(Drilling time, water weathering, etc., if	loss, depth of significant)
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5770 H 12. Hole No. INSTALLATION DIVISION DRILLING LOG OF 3 SHEFT DISTRICT ALBUQUERALVE Sw D , PROJECT 10. SIZE AND TYPE OF BIT WY
11. DAYUM FOR ELEVATION SHOWN (TUM & MSL) ABIQUID DAM

2. LOCATION (Coordinates or Station)

SOUTH ADIT (#2)

3. ORILLING AGENCY 4/08.
TE MANUFACTURER'S DESIGNATION OF BHICL ALD. DIST

4. HOLE NO. (Ae shown on drawing tillet and life number) DISTURBED UNDISTURNED 13 TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 5720 #12 14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER CONTINENTILL DRILLING COMPLETED THE 18" DEG. FROM VERT. 16. DATE HOLE 1939 DVERTICAL MINCLINED 16 NOV , 1989 17 NOV. 17. ELEVATION TOP OF HOLE 6220 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR . TOTAL DEPTH OF HOLE CORE BOX OR SAMPLE NO. REMARKS
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PROJECT BIRUNU JAMA

HOLE HO

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4. HOLE NO. ( and file num	nb ee)		5770 H19	BURG	VEN JAMPE	CO INCE		
S. NAME OF	DRILLER				L NUMBE		OXES	
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6. DIRECTION			7 0	16. DATE	HOLE	•	i	OMPLETED
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7. THICKNES	S OF OVE	RBURDE	<b>———</b>	17. ELE	ATION TO	P OF HOL	E 4010	
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Holo No. 5450 SADIT DIVISION HSTALLATION SHEET / DRILLING LOG 5.W D ALBURUERQUE I. PROJECT 10 SIZE AND TYPE OF BIT XX
11. DAYUM FOR ELEVATION SHOWN (14M & MSL) ABIQUIU DAMA
2. LOCATION (Coordinates or Station) SOUTH ADIT CP 65 ALB DIST.
HOLE NO. (As shown on drawing title)
and tile number UNDISTURBED DISTURBLO 13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN 5150 4. TOTAL NUMBER CORE DOXES 18. ELEVATION GROUND WATER 1959 11 NOV. 14 HOV. 1989 EVERTICAL DINCLINED 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN IS. TOTAL CORE RECOVERY FOR BORING . DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 146= . TOTAL DEPTH OF HOLE REMARKS
(Drilling time, water lose, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS ELEVATION DEPTH LEGEND 4108.87 SAND STONE ! WHITE TO RED, FINE TO MEDIUM ORITINED 6151 MUDSTONE . RED TO DACK BROWN, SOFT, GRITTY IN ATEMS (SAND) HOLE HO PHOJECT

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

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DRILLING		(00111 .	Sheet) FLEVATION		6255			Hole No. 5750 5 Apr	
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Hole No. 5170 SADIT INSTALLATION SHEET DIVISION DRILLING LOG 5 W.D OF 3 SHEETS ALBUKUKKAUE 10. SIZE AND TYPE OF BIT MX
11. DATUM FOR ELEVATION SHOWN (TUM or MISL) ABIQUIU DAM 2. LOCATION (Coordinates or Station)
SOUTH ADIT (#2)
3. ORILLING AGENCY 12. MANUFACTURER'S DESIGNATION OF DRILL CP 65 ALB. DIST.

4. HOLE NO. (As shown on drawing title and file number) UNDISTURBED DISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 57 70 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL 6. DIRECTION OF HOLE DRILLING COMPLETED 6. DATE HOLE 8' NOV, 1959 7 NOU TVERTICAL TINCLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 9. TOTAL DEPTH OF HOLE CORE BOX OR RECOVERY NO. REMARKS (Drilling time, water lose, depth of weathering, etc., if eignificent) 9 CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 6108 SANDSTONE: WHITE AND RED, FINE TO MEDIUM GRATNED 6150 MUDSTANE DARK BROWN TO RED, SOFT, SANDY IN AREAS, CREEN SILTSTINE PRISENT

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11. DATUM FOR ELEVATION SHOWN (TUM or MSL) ABIQUIU DAFM
2. LOCATION (Coordinates or Station) 6/08 8/ SOUTH ADIT (#2) STANWICK ALB. 0157. 13. TOTAL NO. OF OVER- DISTURBED UNDISTURBED 4. HOLE NO. (As shown on drawing title and lile number) 6+10 14. TOTAL NUMBER CORE BOXES S. HAME OF DRILLER 15. ELEVATION GROUND WATER CONTINEN THE BRILL ING COMPLETED STARTED 16. DATE HOLE EVERTICAL DINGLINED. DEG. FROM VERT. 10 NOU, 1989 10 NOV. 1989 17. ELEVATION TOP OF HOLE 6255 7. THICKNESS OF OVERBURDEN 19. TOTAL CORE RECOVERY FOR BORING. 1462 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 146= . TOTAL DEPTH OF HOLE REMARKS
(Drilling time, water lose, depth of weathering, stc., if eignificant) CORE BOX OR SAMPLE HO. CLASSIFICATION OF MATERIALS (Description) DEPTH LEGEND 6108.81 0 SANDSTONE : RED AND WHITE FINE TO MEDIUM GRAINED 6150 MUD STONE! DARK BROWN TO RED, SOFT, SANDY IN ALLAS, DREEN SILTSTAL PRESENT

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4. HOLE NO. and file nu 5. NAME OF				6130	ļ				i		
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Hole No. 6146 DIVISION INSTALLATION SHEET , DRILLING LOG MEBUAUELQUE 5 W 0 PROJECT 10. SIZE AND TYPE OF BIT // Y
11. DATUM FOR ELEVATION SHOWN (TUM or MSL) ABIQUIU DAIM 2. LOCATION (Coordinates or Station) 6/10.10
12. MANUFACTURER'S DESIGNATION OF DRILL SOUTH 3. ORILLING AGENCY ADIT (#2) BTANNICK ALB. DST.
4. HOLE NO. (As shown on drawing title and file number) 13. TOTAL NO. OF OVER-UNDISTURBED 4190 14. TOTAL NUMBER CORE BOXES . NAME OF DRILLER 15. ELEVATION GROUND WAFER CONTINENTAL DRILLING COMPLETED STARTED IS. DATE HOLE 1989 16 NOV, 1989 BYERTICAL MINCLINED. DEG. FROM VERT 15 NOU 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 145-19. SIGNATURE OF INSPECTOR 1458 . TOTAL DEPTH OF HOLE CORE BOX OR SAMPLE HO. REMARKS
(Drilling time, water loss, depth of westlering, atc., if eignificant) CLASSIFICATION OF MATERIALS ELEVATION DEPTH LEGEND 6110 10 SANDSTINE: WHITE AND RED. FINE TO MEDIUM GRITINED. MUDSTANE: DARK BROWN TO RED, SOFT, SANDY INITARAS, SHALL AMOUNT OF GREEN SILTSTONE MESENT ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

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11. DATUM FOR ELEVATION SHOWN (TUM & MSL) ABIQUIC DATE 6110 14 SOUTH ADIT (#z) 12 MANUFACTURER'S DESIGNATION OF DRILL CP 65 MOLE NO. (As shown on drawing III ) and IIIs number 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 7+10 14 TOTAL NUMBER CORE BOXES NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL DRILLING DIRECTION OF HOLE COMPLETED STARTED 16. DATE HOLE 17 NOV 1989 989 DVERTICAL D'INCLINED DEG. FROM VERT 16 NOV 17. ELEVATION TOP OF HOLE 6235 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 145= DEPTH DRILLED INTO ROCK 19 SIGNATURE OF INSPECTOR TOTAL DEPTH OF HOLE 145 T CORE BOX OR RECOVERY NO. REMARKS
(Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND SANDSTONE: WHITE AND RED FINE TO COARSE GRANED 6153 MUDSTONE: DARK BROWNTO RIO, SOFT, SANDY IN AREAS

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(Drilling time, water lose, depth of weathering, etc., if eignificant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 6/11.13 SANOSTONE: WHITE AND RED. FINE TO CEARSE GRAINED 4150 MUDSIDNE: DARK BROWN TO RED SOFT, SANDY IN AREAS PROJECT ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

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Hole No 7+70 5 ASIT DIVISION INSTALLATION DRILLING LOG 5.40.0. OF 3 SHEETS ALBUGUER QUE DISTRICT 10. SIZE AND TYPE OF BIT NX X
11. DATUM FOR ELEVATION SHOWN (TUM or MSL) ABIQUIU JA111
2. LOCATION (Goordine; oe or Station)
SOUTH ADIT (#2)
3 DRILLING AGENCY 12. MANUFACTURER'S DESIGNATION OF DRILL STHANUICK VER- DISTURBED UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 7-70 NAME OF DRILLER 14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER CONTINENTAL

5. DIRECTION OF HOLE PRILLING 16. DATE HOLE GVERTICAL DINCLINED. 18 NOV 1589 17 NOV 17. ELEVATION TOP OF HOLE 6755 7 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 6 DEPTH DRILLED INTO ROCK 144 2 19. SIGNATURE OF INSPECTOR 1442 TOTAL DEPTH OF HOLE CORE BOX OR RECOVERY NO. REMAIN'S (Drilling time, water loss, depth of weathering, etc., if algoritican) g CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGENO 6111.0 SANUSTONE: WHITE AND RED, FINE TO COMPSE CRHINED. 41.19 MUDSTENE' DARK BROWN TO FED, SOFT, SANDY IN HEIAS PROJECT ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE HOLF NO

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			heet) ELEVATION TOP OF	6755			HOIE NO	# 7.70 × 10	4
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11. DATUM FOR ELEVATION SHOWN (TUM & MSL) ABIQUIU DAIM

2. LOCATION (Coordinates or Station) 6110.98 SOUTH ADIT (#2) 12 MANUFACTURER'S DESIGNATION OF ORILL CP65 ALB. DIST.

4. HOLE HO. (As shown on drawing title and tile number) UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 8130 14 TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL. DRILLING 16. DATE HOLE ENTICAL MINCLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 1440 19. SIGNATURE OF INSPECTOR 1441 9. TOTAL DEPTH OF HOLE REMARKS (Drilling time, water lose, depth of weathering, etc., if eignificant) 9 % CORE RECOV-ERY BOX OR SAMPLE NO. CLASSIFICATION OF MATERIALS ELEVATION DEPTH LEGEND 6110.98 SANDSTONE ! WHITE AND RID, FINE TO MEDIUM GRAINED 6150 MUDSTONE DARK BROWN TO RED, SOFT, SANDY IN AREAS HOLE NO. ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE. 81305 ADIF

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PROJECT 10. SIZE AND TYPE OF BIT NX X
11. DAYUM FOR ELEVATION SHOWN (TUM or MSL) A BI WULU BAM LOCATION (Coordinates or Station) 12 MANUFACTURER'S DESIGNATION OF DRILL SOUTH ADIT (# 2) STITAWICK

13. TOTAL NO. OF OVERBURDEN SAMILES TAKEN MLB DIST.
HOLE NO. (As shown on drawing title)
and tile numbed 8150 14 TOTAL NUMBER CORE BOXES NAME OF DRILLER 15 ELEVATION GROUND WATER 6. DIRECTION OF HOLE STARTED .. DATE HOLE FVERTICAL DINCLINED DEG FROM VERT SO NUU 17. ELEVATION TOP OF HOLE THICKNESS OF OVERBURDEN 18 TOTAL CORE RECOVELY FOR BORING DEPTH DRILLED INTO ROCK 144° 19. SIGNATURE OF INSPECTOR 1142 S. TOTAL DEPTH OF HOLE CLASSIFICATION OF MATERIALS (Description) % CORE RECOV-ERY BOX OR SAMPLE NO. DEPTH LEGEND ELEVATION 4111.22 SANDSTONE: REIS AND WITTE FINE ID COARSE CRAINED 4153 MUDSIDNE: DARK BROWN TO RED, SOFT, SANDY IN AREAS, BREEN SILTSTANE PRISENT IN SMHTL AMOUNTS HOLE HS ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROTECT A1316 ... 30 0

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DRILLING LOG

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KILLING	LOG	(Conf 5	heet) ELEVATION TOP OF HOLE	U255 INSTALLATION			Hole No	8150	S ADIT
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Holo No. 0160 N. DEIFT INSTALLATION DIVISION OF | SHEETS DRILLING LOG ALBUQUERQUE DISTRICT 5.W.D 10. SIZE AND TYPE OF BIT /V X
11. DAYUM FOR ELEVATION SHOWN (THM & MSL) PROJECT ADIBULU DAIST 6091.9
12 MANUFACTURER'S DESIGNATION OF DRILL NORTH DRIFT (HI) INFERSOL RAND AZD. MST

HOLE NO. (Ae shown on drawing !!!
and !!!e numbee) UNDISTURBED DISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 0+60 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. ELEVATION GROUND WATER CON TINENTAL DRILLING 16. DATE HOLE 14 DEC, 1889 CHVENTICAL MINCLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 6150 7 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 8 DEPTH DRILLED INTO ROCK 58 % 19. SIGNATURE OF INSPECTOR S. TOTAL DEPTH OF HOLE 58 REMARKS (Drilling time, water loss, depth of weathering, otc., if significant) 9 % CORE RECOV-ERY BOX OR SAMPLE NO. CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 60919 SANDSTONE: WHITE, COARSE GRAINED. 4101 MUDSTANE: DARK RED, SOFT 6115 JANDSTONE' WHITE AND RED MEDIUM - CHARSE CRANED 6136 MUDSTONE: OFFICE FED TO BROWN SOFT. HOLE HO PROJECT ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE ABORDIO JAS.

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DRILL	ING LO	G DI	S.w.D.	INSTALL		ERRUE	DISTRICT	OF 3 SHEETS	
PROJECT				IO. SIZE	AND TYPE	OF BIT	Λ×		
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PROJECT				10. SIZE	AND TYPE	OF BIT	N X SHOWN (YUM or M	
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VERTIC	. AL	NCLINED	DEG. FROM VERT.	16. DATE	- HOLE		JAN, 1990	-1 JAN 1990
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	4'u		MUDSTONE, DAKK FLA TO SOFT, SANDYIN AREA	o Brack,				

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DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE Hole No. 21-10 N DRIFT 6755 SHEET 3 INSTALLATION PROJECT DIST. OF 3 SHEETS ABIOUIU DAM % CORE BOX OR REMARKS
(Drilling time water loss, depth of weathering, etc. if rightfume) CLASSIFICATION OF MATERIALS (Description) LEGEND DEPTH ELEVATION ĸ SANDSTONE AS ABOVE 110 SANDSTONE + MUDSTONE; 507, MS, 5070 SS, burn 130 TO H. PROJECT HOLE NO ENG FORM 1836-A (ER 1110-1-1801) OPO 1980 OF - 628 603 7140 NOR11. ABIUUU DAM

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Hole No. STELLET /
STRICT OF 3 SHEETS

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3 TOTAL DE			160-		19. SIGN	TURE OF	INSPECT	OR			
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TO SERVICE TRANSPORTER

Hole No. 3466 N DEIFT

	ING LO	G	3.w.D	<u> </u>			CE DISTRICT OF 3 SHEETS
PROJECT	42.0	والإن ماد	n7		M FOR EL		SHOWN (TUM & MSL)
LOCATION	(Constin	100 0, Stat	(lon)			409	
DRILLING	AGENCY	31.11	(7.7)	12 MANG	FACTURE		ER SOL RIAND
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DIRECTIO	N OF HOL	Ε		16. DATE	HOLE	•	TANV, 1990 4 JAN. 1990
				17. ELE	ATION TO		
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LEVATION		1	CLASSIFICATION OF MATERIA (Description)	\LS	% CORE RECOV- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
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ROJECT			heet) ELEVATION TOP OF HOLE  6255 INSTALLATION			more IVO.	SHEET 3
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SHEET 1 Hole No. DIVISION INSTALLATION DRILLING LOG 01577117 OF 3 SHEETS 5 w. D AzBUQUERQLE I. PROJECT 10. SIZE AND TYPE OF BIT // X
11. DATUM FOR ELEVATION SHOWN (TUM of MSL) ABIBUIU DAM

2. LOCATION (Coordinates or Station)

NORTH DRIFT

3. DRILLING AGENCY 6095 INDESOL ZAND A28 DIST
HOLE NO. (As shown on drawing title and lile numbed) UNDISTURBED 3+60 #5 14. TOTAL NUMBER CORE BOXES NAME OF DRILLER 15 ELEVATION GROUND WATER CONTINENTAL S. DIRECTION OF HOLE DRILLING STARTED COMPLETED 16 DATE HOLE 1271N 1990 2 5HN, 1990 L'VERTICAL MINCLINED 17 ELEVATION TOP OF HOLE 6255 7. THICKNESS OF OVERBURDEN 18 TOTAL CORE RECOVERY FOR BORING B DEPTH ORILLED INTO ROCK 1890 19 SIGNATURE OF INSPECTOR TOTAL DEPTH OF HOLE 189 : CORE BOX OR SAMPLE NO. REMARKS
(Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) DEPTH LEGEND ELEVATION ď 6015 NOTE EMUAINENS CALCULA IND CAM ANGER (CONVERTED TO VERMINAL MEASURMENTS NOTE IN COM ALPTION UBTALLED CHEY HETER 15,32, SANDSTANE: WHITE, MEDIUMI (PAINED MUDSTONE: DARK KED TO BROWN SOFT PROJECT HOLENO ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE ABraun DAM

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Hole No. 2190 N 1101T

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	6. DIRECTION				16. DATI	HOLE			DEC, 1959	
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Hole No. 3+56 N HAIT DIVISION SHEET DRILLING LOG ALBUQUERQUE OF I SHEETS 5 W.D 1. PROJECT 10. SIZE AND TYPE OF BIT ANY
11. DATUM FOR ELEVATION SHOWN (TEM or MSL) ABIQUIU DAM LOCATION (Coordinates of Station) 6010.1 NORTH ADIT 12. MANUFACTURER'S DESIGNATION OF DRILL . ORILLING AGENCY 0006-2 ALB. UNDISTURBED DIST. 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED B. HOLE NO. (As shown on drawing title and file number) 3150 14. TOTAL HUMBER CORE BOXES HAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENT! L. PRILLING ICOMPLETED 19 DEC, 1789 DVERTICAL DINGLINGO. \_ DEG. FROM VERT. 17. ELEVATION TOP OF HOLE THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 40-S. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR TOTAL DEPTH OF HOLE 60 % CORE BOX OR SAMPLE NO. REMARKS
(Drilling time, water loss, depth of westforing, etc., if significant) CLASSIFICATION OF MATERI .LS ELEVATION DEPTH LEGEND 60904 SANDSTONE: WHITE, COARSE GRAINED 6104 MUDSTONE DANK RED, SOFT 4120 SANDSTONE: WHITE, MILIDIUM TO COAKSE GRAINED 4137 MUNSTONE: DARK IZED TO ISRDIUN SOFT T.O H. 6150

ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT

HOLE HO

4/10 N ADIT Hole No. INSTALLATION SHEET ( DRILLING LOG OF | SHEETS ALBU & LERROY DISTRICT

10. SIZE AND TYPE OF BIT NX

11. DAYUM FOR ELEVATION SHOWN (TUM or MSL) SWD. PROJECT ABIGUIU UAMA
2. LOCATION (Coordinates of Station) NORTH ADIT 12. MANUFACTURER'S DESIGNATION OF DRILL INGIRSOL ALB. DIST

I. HOLE NO (Ae shown on drawing title
and file number) 13. TOTAL HO. OF OVER-BURDEN SAMPLES TAKEN 4+10 14. TOTAL NUMBER CORE BOXES . NAME OF DRILLER 15. ELEVATION GROUND WATER CONTINENTAL DRILLING COMPLETED DVERTICAL DINCLINED\_ 17. ELEVATION TOP OF HOLE 4150 7. THICKNESS OF OVERBURDEN \_\_\_ 18. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR 9, TOTAL DEPTH OF HOLE CORE BOX OR RECOV-ERY NO. REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) 9 CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND 6091.4 SANDSTONE : WHITE , COARSE GRANKO 4104 MUDSTONE: DAKK RID, SUFT 15 6118 SANISTONE! WHITE AND BROWN, FINE TO MEDIUM GRATNED, 10-15% MUDSTINE MUDSTONE: DARK RED TO BROWN, SOFT. T.U H. = 6150 HOLF NO ENG FORM 1836 PREVIOUS EDITIONS ARE OSSOLETE PROJECT

Hole No. 4170 N ADIT INSTALLATION SHEET / DIVISION DRILLING LOG OF | SHEETS 5.w. 1) ALBULUERQUE 1. PROJECT 10. SIZE AND TYPE OF BIT A X

11. DATUM FOR ELEVATION SHOWN (TBM or MSL) ABIQUI DAMI 2. LOCATION (Coordinates or Station) 6092.4 NORTH ADIT (#1)
3. DRILLING AGENCY 12. MANUFACTURER'S DESIGNATION OF DRILL SPARMICK ALB UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER 15. FLEVATION GROUND WATER CONTINENTAL. DRILLING 22 DEC, 1989 27 DEC, 1989 STERTICAL SINCLINED DEG. FROM VERT 17. ELEVATION TOP OF HOLE 4150 7. THICKNESS OF OVERBURDEN 16. TOTAL CORE RECOVERY FOR BORING 8. DEPTH DRILLED INTO ROCK 58 s 19. SIGNATURE OF INSPECTOR 9, TOTAL DEPTH OF HOLE 585 CORE BOX OR SAMPLE NO. REMARKS
(Drilling time, water loss, depth of weathering, etc., if significant) CLASSIFICATION OF MATERIALS (Description) ELEVATION DEPTH LEGEND ď 60924 SANOSTONE: WHITE, COARSE GRAINED 6099 MUDSTONE: DARK RED, SOFT 6118 SAMOSTONE: WHITE AND BROWN. FINE TO MEDIUM ORATNED, 10.15% MU DSTINE 30 4135 MIDSTONE! DARK REN TO BROWN, SOFT 45 HOLE NO ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE PROJECT 412 Cal = ABIGUIU DAM

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Holo No WILL IN ADIT SHEET DIVISION INSTALLATION DRILLING LOG OF 2 SHEETS ALBUALIZALE DISTRICT PROJECT 10 SIZE AND TYPE OF BIT 10 SIZE AND TYPE OF BIT WX THAT IN MISL ABIBULV DAMA
2. LOCATION (Coordinates of Statley 409-/ NORTH ADIT (H. 101) (rE ALB. DIST 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 4. HOLE NO (As shown on drawing title) and tile number) 4+10 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER IS. ELEVATION GROUND WATER CONTINENTAL 16 DATE HOLE 9 JAN, 1990 9 1712 BYERTICAL MINCLINES DEG. FROM VERT 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING DEPTH DRILLED INTO ROCK 19. SIGNATURE OF INSPECTOR TOTAL DEPTH OF HOLE REMARKS
(Drilling time, water lose, depth of weathering, etc., it eignificant) CORE BOX OR RECOV-ERY NO. CLASSIFICATION OF MATERIALS (Description) DEPTH LEGEND 4074 SANDSTONE! WHITE, CHARSE CRAINED 4100 MUDSTONE! DARK RED, SOFT 4114 SANDSTONE, WHITE AND BROWN, FINE TO MEDIUM GRAIN D, 20% MUDSTONE 6132 MUDSPINE' PARK RIS TO PROWN SANDY THROUGH OUT. HOLE HO PROJECT

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LEVATION	DEPTH	LEGEND	CLASSIFICATION OF	MATERIALS		BOX OR	(Drilling time	REMARAS
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Hole No. INSTALLATION DIVISION DRILLING LOG S.w.D. 10. SIZE AND TYPE OF BIT XX
11. DAYUM FOR ELEVATION SHOWN (TEM & MSL) MBULUERAUE ABIGUIU DAM 2. LOCATION (Coordinates of Station) 0016. 3

12. MANUFACTURER'S DESIGNATION OF DRILL

CP65 NORTH ADIT (#1 AZB. DIST.

HOLE NO. (As shown on drawing title and ille numbed) UNDISTURBED 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 8+50 14. TOTAL NUMBER CORE BOXES S. NAME OF DRILLER IS ELEVATION GROUND WATER CONTINENTAL DRILLING 16. DATE HOLE 18 JAN, 1990 17 JAN 1990 TERTICAL DINCLINED DEG FROM VERT 17. ELEVATION TOP OF HOLE 4255 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING , DEPTH DRILLED INTO ROCK 159 19. SIGNATURE OF INSPECTOR 1512 9. TOTAL DEPTH OF HOLE CORE BOX OR SAMPLE NO. REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) 9 CLASSIFICATION OF MATERIALS DEPTH LEGENO ELEVATION 40163 MOTE · MECKINATION OBTAINED UNLY AFTER **3**3 6137 MUDSTONE DARK RED TO BROWN, SOFT ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO

ABIANU DALL

515' x AD

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Hole No. 9+54 13 N ADT DIVISION INSTALLATION SHEET ! DRILLING LOG 5. W. D OF 3 SHEETS DISTRICT Yrbnaneka ne 10. SIZE AND TYPE OF BIT XX 11. DATUM FOR ELEVATION SHOWN (TEM or MSL) ABIGUIN DAM

2. LOCATION (Coordinates or Station) 4097
12. MANUFACTURER'S DESIGNATION OF DRILL NORTH ADIT (#1)
DRILLING AGENCY INCERSOL ALB. DIST. 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN UNDISTURBED HOLE NO. (As shown on drawing title and tile number) #3 9+54 14. TOTAL NUMBER CORE BOXES 15. ELEVATION GROUND WATER CONTINENTAL DRILLING 16. DATE HOLE 16 DEC, 1989 DVERTICAL WATCHINE 1500 C 17. ELEVATION TOP OF HOLE 6260 THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR BORING 1735 S. DEPTH DRILLED INTO ROCK (163 VELT) 19. SIGNATURE OF INSPECTOR 9. TOTAL DEPTH OF HOLE 173 (163 VERT) BOX OR SAMPLE NO REMARKS (Drilling time, water lose, depth of weathering, etc., if eignificant) 9 CLASSIFICATION OF MATERIALS (Description) DEPTH 6047 SANDSTONE: WHITE COARSE LZAINED 4100 MUDSTONE: DAKK RED, SOFT NOTE THE ATTEMS FEEL VE 4115 USING PA'LL CONVERTED SITNUSTONE: WHITE AND RED, TO VERTICAL DISTINCES MEDIUM TO COARSÉ GRAINED 6131 MUDS TONE. PARK RED TO KOUN, SOFT

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RILLING	LOG (Cont Sheet) ELEVATION TOP OF HOLE 6235			Hole No. 10180 #5 N 101		
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